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NATIONAL PARKS AND THEIR USE

THE main theme of the recent meeting of the British Association at Birmingham was energy in the service of man; but in developing this theme in his presidential address Sir Harold Hartley emphasized the need for balance and for conservation in the development and utilization of world resources. The need for an ecological approach to the problems of to-day was noted in one or two of the sectional addresses and in such discussions as those on forestry in water-catchment areas, the factors limiting food production in Britain and the rehabilitation of derelict areas, as well as in the scientific survey, "Birmingham in its Regional Setting", prepared for the meeting. The address which Sir Patrick Duff gave before the Conference of Delegates of Corresponding Societies on September 4 was thus in harmony with the main theme of the meeting. Moreover, the early establishment of nature reserves in Britain and the effective working of the Nature Conservancy are matters of immediate concern to several sections of the Association.

Only a small audience, however, listened to this general account of the projected work of the National Parks Commission from its chairman, and which admirably supplemented the pamphlet on "National Parks and Access to the Countryside"* already issued by the Ministry of Town and Country Planning and the Central Office of Information. Apart from its excellent historical survey, that pamphlet presents a scrupulously fair account of the Act and of the essential criticism that has been advanced of it. Sir Patrick naturally did not enter on controversial issues, but he was equally fair and made it plain that the success of the national parks experiment in Britain, and indeed also of the nature reserves (for the latter the Commission has no responsibility), depends on enlisting sufficient help, interest and enthusiasm from the scientific community. Intelligent and public-spirited people are needed to spread awareness of what areas of unspoiled countryside mean to the nation, and to foster the idea of considerate behaviour and of mutual respect between towns-folk and country-folk.

Sir Patrick's address to the Conference was well designed to assist that task of education and to remove some of the popular misconceptions. He pointed out, for example, that the proposed parks are only 'national' in the sense that the whole country has a deep public interest in keeping relatively unspoilt the country that comprises the parks, and that for certain purposes national funds can be made available in respect of them. The real effect of designating any area as a national park is, as pointed out in the annual report of the Council for the Preservation of Rural England†, first to bring a new planning machinery into being, and to apply higher planning standards in controlling and directing

* National Parks and Access to the Countryside. Pp. 16 + 7 plates. (London: H.M. Stationery Office, 1950.) 6*d*. net.

† Council for the Preservation of Rural England: Annual Report, 1949–50. Pp. 56. (4 Hobart Place, London, S.W.1.)

development, and, secondly, to give the planning authority new powers of so 'managing' the park as to provide more effectively for the accommodation and convenience of its visitors. The normal life of the area and the agricultural and other activities of its inhabitants would continue as before, and, as regards public access, the designation of a national park would in itself effect no change at all.

Sir Patrick confirmed that it is hoped to designate the Lake District, Snowdonia and the Peak District as national parks by the end of 1950, and he quoted with approval the principle laid down by the late John Dower in his report in May 1945 that such designation should mean that in such areas, of the possible purposes for which the land might be used and developed, two must stand supreme: the characteristic beauty of the landscape shall be preserved; and the visiting public shall have ample access and facilities within it for open-air recreation and for enjoyment of its beauty. Other and utilitarian purposes are not excluded, but within such areas they must be controlled and harmonized with these dominant purposes. The administration would not, Sir Patrick admitted, lie with the Commission, but with the local planning authority; and he recognized that the entire success of this great experiment depends on the co-operation of the local authorities with the Commission and with each other, and on the enthusiasm and competence of the local administration.

The recent annual report of the Council for the Preservation of Rural England, from which Sir Patrick quoted, provides for the publicity which his address by itself is unlikely to receive. Moreover, its observations indicate the importance of certain questions which Sir Patrick himself did not raise, but which bear as closely on the success of the national parks and the nature reserves as any that he mentioned. It is clear that the Council is as alive as the National Parks Commission to the importance of seeing that the increased facilities for public enjoyment of the countryside which the Act provides should not result in damage to property, interference with agriculture or inconvenience to people who live and work there. Its greatest concern, however, is with the adequacy of the administrative arrangements for both the national parks and the Nature Conservancy for fulfilling their declared purposes in the face of the threats which are offered by government departments and public undertakings.

Like the report from the corresponding Council for Rural Wales, the report is emphatic that the demands of the Service departments represent the most serious of these threats. There is still no sign of any attempt to co-ordinate such demands, and both reports comment strongly on the unexplained and well-nigh incredible delays which occur in announcing the Government's decisions on cases which have been the subject of public inquiries. Since the last annual report of the English Council was published, nearly a hundred and fifty requirements, frequently involving encroachment upon agricultural land, have come under consideration by the Council's Executive Committee, and details of a few of these are included in the report. Sometimes objection has not been necessary, and in general the Service departments appear to be less blameworthy than some others in regard to agricultural land. But though only five public inquiries were held during the year, the manifest misgivings of the Council as to the true value and purpose of such public inquiries generally in connexion with the Services' land requirements should be heeded by the Government.

No responsible section of opinion will deny the necessity for setting aside land for Service training purposes; but equally, no responsible person fails to recognize that there is a limit to the amount of land which can be allocated for that purpose. The piecemeal formulation of the Services' land requirements, the failure to co-ordinate them and to take account of that limit, and the manner in which the public inquiries are conducted, dissipate much goodwill and create an atmosphere of distrust and frustration in which the co-operation required to make national parks or nature reserves effective will be increasingly difficult to secure. The report itself directs attention to the way in which slight extensions have repeatedly been made to the boundaries of Services' lands after requirements have been fully investigated and finally approved, and these have led to apprehension which does much to frustrate the policy of 'good neighbourliness' which the Services often profess.

Although the matter of Service lands causes the widest disquiet, there are many other directions in which, as this report indicates, constant vigilance is required. The County Councils' Association in its sixtieth annual report commented upon the lack of co-operation of some government departments and their failure to consult with the local planning authorities in the erection of buildings and in development generally on government property. The Council for the Preservation of Rural England refers particularly to the development attending the Atomic Research Station at Capenhurst in the Wirral, and in this connexion comments that while there is no desire to put obstacles in the way of urgent developments in the national interest, planning authorities cannot carry out their statutory duty to prepare schemes, when they are not consulted about this type of development, their protests dismissed and public opinion disregarded. The difficulties of administration already indicated are increased by such remissness.

Fundamentally the trouble here, as in the matter of Services' lands, is one of departments being allowed to judge their own cause, and the Council for the Preservation of Rural England derives much of its value from its ability to take a wider and national point of view. Elsewhere in its report, for example, with reference to the indiscriminate tipping of colliery waste, overburden from stone, gravel and clay workings and tunnel excavation, as well as household refuse, which has been a matter of concern particularly in Lancashire, Shropshire and the Peak District, the Council expresses the view that the National Coal Board should not be given the privileged position of a statutory undertaker regarding the right to claim compensation in respect of the under-

ground working of coal and certain associated minerals. If the local planning authority or the Minister on appeal is satisfied that the tipping of colliery waste on a certain site is so detrimental to amenity, when weighed against the nation's need for coal, that it is contrary to the public interest, it is unreasonable that the Board should be entitled to claim compensation, or that the cost of compensation should deter the authority from refusing consent or imposing such conditions as the circumstances require.

The Council does not, as a rule, become involved in the development of new towns, but it is worth noting that the Council decided to support its Cheshire Branch and the Cheshire County Council in opposition to the Manchester proposals for a new town at Mobberley on the grounds that the project involved sacrifice of a large area of good farming land, wide trespass over the Manchester Green Belt and the almost certain urbanization of a large area in this direction which Parliament had previously rejected. The Council has played its part, with other bodies, in obtaining a reprieve for the ancient community in the picturesque village of Letcombe Bassett, and the joint survey of the small communities of England and Wales which the Council is sponsoring in association with the Council for Rural Wales and the National Association of Parish Councils should help to check the tendency for the value of small villages in the rural life of the country to be overlooked in planning rural areas. The questions of open-cast coal mining and of iron-ore working are again prominent in the report, which gives a picture of the extent to which the destruction of productive agricultural land and the creation of appalling unsightliness while the work is in progress have now involved no fewer than seventeen counties.

The Council has made representations to the Minister concerned both on issues of national principle and on individual uses. In regard to the former, one passage in the report would seem to point to dereliction of duty on the part of scientific men. Early this year, it was announced that a country-wide investigation of the problems involved in the restoration of farm land had been initiated by the Ministry of Agriculture and that a major scientific survey of the whole question would be undertaken. Since, however, it is estimated that the survey will take three years, by which time the damage should be on a diminishing scale since open-cast coal mining will have passed its peak, the survey seems late in the day. Scientific men, who are as well aware as the Council itself that at present such agricultural requirements as the restoration of soil fertility, of land drainage after settlement, and the re-establishment of tree plantations are not being satisfied, might well have been expected to protest earlier and more vigorously.

Apart from the loss of landscape amenities, itself a dollar-earning asset, and the human and social problems involved, it is stated that open-cast coal mining operations have so far resulted in a loss of nearly £14,000,000, without taking into account the long-term loss of food production. Nor has any noticeable progress been observed or any effective government policy evolved for dealing with the devastation caused by iron-ore working in the Midlands and Lincolnshire. Apart from the neglect of research into the problem of effective restoration, the long-term plans of the iron-ore companies involve 70,000 acres of Northamptonshire, some 25,000 acres of Rutland and extensive areas of Leicestershire and Lincolnshire, including twenty-four square miles round Clipsham and Holywell, the scientific value of which was emphasized in the Huxley Report on the Conservation of Nature in England and Wales in 1947. Although it is understood that the Minister of Town and Country Planning hopes to make a statement to Parliament in the form of a White Paper indicating Government policy as soon as possible, the statement will be awaited with some anxiety in absence of any decision as to the responsibility for the financial cost of restoration.

Like action has been taken in regard to proposals for opening new lime, cement, gravel and quarry workings and extending existing workings. Here again the Council's approach has been thoroughly practical, and has usually taken the form of helping the planning authority to secure the necessary measures of control by insisting on conditions which will ensure adequate after-treatment of the scars, screening and, where applicable, restoration to farming use. It is anticipated that the Ministry of Town and Country Planning will make future licences contingent upon an undertaking to restore the excavated site to its original use whenever possible, or to level it satisfactorily for some other useful purpose.

In this field of activity it would appear, especially when the willingness of industry to co-operate is noted, that a new attitude to the exploitation of natural resources and appreciation of the importance of ecological considerations are more widespread. This is scarcely as true of hydro-electric power developments, which are a matter of particularly grave concern to the Council for the Preservation of Rural Wales, in the current annual report of which* it holds the most prominent place. The Friends of the Lake District have lately directed attention to a serious threat to the Esk and Dudelm valleys; but the Council for the Preservation of Rural England, while supporting the Welsh Council and the North Wales (Hydro-electric) Protection Committee in opposition to the proposed hydro-electric schemes in North Wales, in its present report is concerned chiefly with the siting of pylons and supply lines and with securing the use of underground cables rather than overhead lines, so as to avoid disfigurement to landscape or skyline in such areas as Eskdale or the Malvern Hills.

The present position of the Welsh schemes is explained both in the annual report of the Welsh Council and in a pamphlet setting forth the case against the schemes which was issued earlier in the year by the Protection Committee. It now appears to be unlikely that the British Electricity Authority

* Council for the Preservation of Rural Wales: Annual Report, 1949–50. Pp. 36. (Aberystwyth and 4 Hobart Place, London, S.W.1.)

will be ready to present a Bill this year, although the expense of opposition if a Bill reaches Parliament is the main immediate reason for anxiety; the Protection Committee has still to raise the necessary funds, and the financial position of the Council for the Preservation of Rural Wales continues to be precarious. The preliminary surveys for the Snowdon and Mawddach schemes have not yet even been begun, and in replies to questions from Welsh members of parliament, the chairman of the Authority, Lord Citrine, indicated that the strongly opposed Snowdon scheme was not regarded as indispensable. The Authority must decide whether this scheme is to be postponed indefinitely before tabling its Bill, and in the meantime the statement issued by the North Wales (Hydro-electricity) Protection Committee raises some highly important questions as to the value of the whole project, which would take fifteen to twenty years to complete. As has been pointed out in the report from the Welsh Council, the Galloway Hydro-electricity schemes differ too widely in nature and scale to permit any useful comparison with the proposed developments in North Wales. Whether the schemes are, in fact, the best way of supplying electricity to those parts of rural North Wales which so far have none, whether they represent the most effective means of distribution, and whether the schemes will, in fact, benefit the Welsh hill farmer, are flatly challenged by the Committee, the arguments of which appear to demand much more careful attention than they have yet received.

Other matters, such as the prevention of river pollution, afforestation, and the preservation of trees, are dealt with in the reports of both Councils for the Preservation of Rural England and of Rural Wales and of their branches, though naturally to a varying extent. That from the Sheffield and Peak District Branch* has been particularly concerned, for example, with building matters, countryside behaviour, industrial defacement and quarrying, and directs attention to a report by Mr. E. Morton on "The Effect of the Quarrying Industry on the Scenery of the Peak District National Park" which has just been issued by the Joint Committee for the Peak District National Park. Service land requirements in this area, however, appear to have caused less difficulty or friction than elsewhere, and the main impression derived from the report of this Branch is one of unceasing vigilance and quiet, tactful and effective action as required.

What is clear from these reports is that much can be done to reconcile opposing interests and secure effective co-operation even by voluntary and advisory bodies, and the possibility of achieving in Britain a satisfactory system of national parks and of nature reserves and of safeguarding much that yet remains in our scenic heritage by such a characteristic British means need not be dismissed as impracticable. For success, however, there are two essential conditions: first, an authority, if necessary at Cabinet level, competent to resolve interdepartmental difficulties and to ensure that no department, however important, is able to prevail over the broad national interest; secondly, an effective administrative system for the national parks, competent to ensure effective planning and the adoption of reasonable standards and to establish beyond controversy such vital details for the guidance of the planning authorities. Sir Patrick Duff passed rather lightly over this point, and the memorandum since issued by the county councils of Derbyshire, Cheshire and Staffordshire gives no convincing evidence that a joint advisory committee is likely to prove even as effective an instrument for carrying out the purposes of the National Parks Act as a joint board. If voluntary and advisory bodies are to prove effective, they will at least need the active and intelligent support of all members of the community who care for the purposes of the Act, and not least of those men of science who are qualified to advise on the use and development of the land and its natural resources, the conservation of our flora and fauna, the restoration of exploited or devastated areas, and the prevention or mitigation of nuisances or pollution.

* Council for the Preservation of Rural England, Sheffield and Peak District Branch: Annual Report, May 1950. Pp. 24. (Endcliffe Vale House, Sheffield 10.)

A NEW TAXONOMIC STUDY OF THE *CLAVARIÆ*

A Monograph of *Clavaria* and Allied Genera

By E. J. H. Corner. (Annals of Botany Memoirs, No. 1.) Pp. xv+740+16 plates. (London: Oxford University Press, 1950.) 105*s*. net.

IN 1905, Mr. A. D. Cotton, then at the Herbarium of the Royal Botanic Gardens, Kew, commenced a revision of the genus *Clavaria*, using micro-characters as well as field characters. In 1922, in joint authorship with Miss E. M. Wakefield, he published a revision of the British *Clavariæ*, in which thirty-seven species of *Clavaria* were keyed out and described. On principle, micro-characters were never used to separate one species from another unless the plant was also amply distinct in form, colour, or other field character.

In 1925, Mr. E. J. H. Corner selected for particular study the family Clavariaceæ "as the well defined group of the Homobasidiomycetes fundamental to the whole, yet so rarely mentioned in text-books as to seem without importance", and in this year he has published on them this book of 740 pages, illustrated with 298 beautifully drawn text-figures and sixteen coloured plates. During this period Mr. Corner has developed a theory that the fruit bodies of Basidiomycetes can be understood only after having been subjected to hyphal analysis. The impact upon an English fungus flora may be appreciated from this. Cotton and Wakefield's thirty-seven British species of *Clavaria* appear in this book as ten species of *Clavaria* Fr. (1821), seven of *Ramaria* S. F. Gray (1821) emend. Donk (1932), four of *Clavulina* Schroet. (1833), five of *Clavariadelphus* Donk (1933), two of *Ramariopsis* Donk (as subgenus 1933), seven of *Clavulinopsis* Corner (1950) and one species of *Aphelaria* Corner (1950).

This book is not written primarily for British mycologists but to give tropical mycologists the means of identifying clavarioid fungi, "to the extent that what cannot be named from its pages with certainty should be described as new". To this

intent the form, colour and other field characters of the reputed species have themselves been subjected to close hyphal analysis.

The character of the form of the fruit body has been studied with reference to its apical growth. The fruit bodies of other Basidiomycetes develop by coherent centrifugal growth; the clavarioid fruit body, on the contrary, ceases growth before branching and resumes it at numerous micro growing-points that are arranged in a line for flattened branching or in a circle for radial branching. The simple fruit body is homologous with the stipe of branched ones, the crustate appearance of which, when present, is diagnostic of the genus *Clavulina* and indicates loss of control of apical growth. High importance is attached to colour; but it is immensely important to establish wherein the colour resides, whether in the cell wall, the cytoplasm, the oil drop of the fresh spore, or is developed as an after-effect of drying. As a field character, toughness, when tested by hyphal analysis, covers no less than six generic categories.

Five types of hyphal constructions are recognized. The pteruloid series of genera are characterized by dimitic fruit bodies, that is, they have two systems of hyphæ, the thick-walled, colourless, almost unbranched skeletal hyphæ, and the generative hyphæ. The remainder are monomitic. In these, the cells of the hyphæ just below the growing-point often swell and lengthen—a character here denoted as inflation. The hyphal analysis of the fruit bodies of the monomitic genera distinguishes four conditions: with normal inflation and with clamp-connexions; inflation with secondary septation of the inflated cells, but without clamps; no inflation; and no inflation, but with dichophyses, that is, dichotomizing hyphæ with limited growth, and with thick brown walls.

Thus armed, Mr. Corner has attacked the genus *Clavaria*, "the original receptacle for all Clavarioid Basidiomycetes", and which has received at one time and another more than five hundred species. He accepts Dr. Donk's choice of *C. vermicularis* Fr. as the type species of the name *Clavaria*, and round it has collected "24 certain species, 16 possible species and 22 incertæ sedis". *Clavaria* is here restricted to species which have fruit bodies with medullary hyphæ that are thin-walled, inflating, without clamps, and generally secondarily septate. *Ramariopsis* is maintained for fleshy clavarias with small, white, rough spores. *Clavulinopsis* embraces most of, if not all, the yellow and orange clavarias with white spores; and *Clavulinopsis* can be recognized by its basidia, which are more or less cylindrical, and finally septate after spore discharge, and by its spores, always two and somewhat broader than the basidium.

The largest accepted segregate from *Clavaria* is "*Ramaria* S. F. Gray, emend. Donk", which takes the species with branched-fruit bodies and spores with ochraceous-coloured spore walls. This name is taken up, in preference to *Clavariella* Karst., because "the name must be accepted in some sense, when *Clavaria* is split up into several genera". The treatment of *Ramaria* suggests that the new taxonomy will not be completed without the help of chemists. The geneticists, on the other hand, do not fare so well: Mr. Corner will have none of the classifications based upon the orientation of nuclear spindles.

The very large amount of new matter that adorns this book derives from the author's own collections in Great Britain and Malaya. In the tropics these fungi appear in great quantity, all at once, and quickly decay. As a routine, material was collected in the morning, enough for the day; colour notes and preliminary microscopic examinations followed, spore prints were made, specimens dried, and one sporing sample preserved in alcohol-formalin. The same species was repeatedly examined alive; painting them was usually reserved for another season. In all, a hundred and twenty species have been collected by the author and, together with authentic material of another sixty species, have been subjected to hyphal analysis. On this basis, and on a study of world literature, he 'recognizes' 540 species and has distributed them into twenty-eight genera, nine of which are new.

The genera with clavarioid characters are arranged into six series of which the hyphæ of the first three are not inflating. The pteruloid series based on *Pterula* Fr. are to be recognized by their dimitic hyphæ, and have no known associates among the other Basidiomycetes. The two genera of the xanthochroic series have relatives in every other group of Basidiomycetes; they are to be recognized by their brown hyphæ which become browner still in potash; this group is the same as the Hymenochætoideæ Donk. The thelephoroid series (based on *Thelephora*) are known by their flattened branching, and rough and angular spores. The other three, that is, those with inflating hyphæ, are the *Ramaria* series, the *Clavariadelphus* series based on *Clavaria pistillaris*, in which apical branching is unknown, and the *Clavaria* series.

The main body of the text is taken up by two chapters. One of 140 pages is headed "Taxonomic and Morphological Notes on Genera". In this, the origin and Mr. Corner's circumscription of each accepted genus are explained. The other chapter, headed "Classification", consists of 500 pages. It includes a "natural key", that is, one that approaches the genera through Mr. Corner's six-series plan, and an artificial key, which approaches them otherwise. Then the genera are taken in alphabetical order, each with its full diagnosis and a key to the species, which are then taken one by one. The book finishes with a list of clavarioid genera (with their synonyms and type species); the Latin diagnoses of all new genera, species, and other groupings; a short general bibliography; and a complete index to genera, species and synonyms.

As Mr. Corner notes, in his introduction, the group of genera with clavarioid fruit bodies has attracted extremely little attention in text-books; and, he might have added, except for a minute number of specialists, extremely little attention at all. In the Kew Herbarium, which in about thirty years has received more than forty thousand accessions, mainly from plant pathologists, only a single specimen of a clavarioid fungus has been sent in for identification. Among the thousands of collections that have been made by the staff, only a single clavarioid fungus has been brought in, and then because it was mistaken for a Hyphomycete. As is well known, the soil scientists are unwilling to include in science anything that has not appeared in one of their Petri-dish platings, so that even the clavarioid fungi, that can cover the ground, remain unknown to them. It is, however, almost impossible to believe that the vistas which Mr. Corner has opened up will not attract newcomers to a field that he has made fascinating.

E. W. Mason

POULTRY GENETICS

Genetics of the Fowl

By Prof. F. B. Hutt. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. xi+590. (London: McGraw-Hill Publishing Co., Ltd., 1949.) 55*s*. 6*d*.

AN exhaustive compendium on the genetics of the domestic fowl has been wanting for a long time. The author now provides one which is in the same noteworthy class as the works of Grüneberg on the rat and Stern on man. This book is likely to be the standard work on the subject for many years. The literature on poultry genetics is already large, the number of references given being about 1,150; in a volume of 590 pages this means an average of about half a page per reference, so that the reader will generally find information about every conceivable aspect of poultry genetics usefully and skilfully concentrated. It is possible, however, that authors from the Continent of Europe do not always receive their fair share of attention, this being a not infrequent fault in books written by authors whose mother tongue is English.

There are fifteen chapters in all, the most useful to the breeder being those on egg production, genetic resistance to disease, and genetics in practice. One could have wished for a more extended consideration of this last subject, as it is here that the wisdom and sound judgment of the author are made most evident. In spite of his obviously great technical knowledge he admits that it is "with considerable misgiving that the author ventures to suggest how to improve our domestic fowls by breeding". A careful reading of the chapter on genetics in practice leads me to advise the author to get rid of this misgiving as soon as possible.

Knowledge about any useful animal can almost always be of use to workers on other animals. It is not clear whether the gigantic egg-production scheme of the Gambia is under competent genetic guidance; but if it is not, the authorities may like to take to heart the valuable information given on pages 439–40 about the behaviour of stock bred in one country when transferred to another. The Gambia scheme involves the use of vast numbers of the Rhode Island Red breed imported from the United States. It is here pointed out that breeds and strains of fowls which are excellent in one part of the world are often quite unsuitable when transferred to another. This is particularly the case with birds imported to tropical countries from Europe and North America. In most cases the imported stock is susceptible to diseases and parasites to which it had not previously been exposed. By contrast the native fowls are much hardier and, one might add, will respond quickly to genetical selection at higher nutritive levels than those to which they are accustomed.

The author also points out that genetical considerations are often ignored in the control of disease. This is mainly due to the fact that methods of control are based on the recommendations of bacteriologists and veterinarians, whose sole aim is to eradicate the disease. In the case of the pullorum disease of fowls, this is done by eliminating all birds carrying the pullorum organism. The author states: "In the attempt to accomplish it, one envisions little armies of blood testers struggling on to the millennium, while as a result of their labours the poultry population, in the absence of any natural selection, becomes more and more susceptible". Should not, we might ask, genetical considerations play a large part in the control of tuberculosis and of foot and mouth disease in cattle?

This book should be used as a work of reference by geneticists, animal breeders and general biologists. There are a few misprints. S. C. HARLAND

PETROLEUM IN PRODUCTION AND REVIEW

Conversion of Petroleum

Production of Motor Fuels by Thermal and Catalytic Processes. By Dr. A. N. Sachanen. Second edition, revised and enlarged. Pp. xii + 602. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 66*s*. net.

Petroleum Production

By Park J. Jones. Vol. 5: Oil Production by Gas and Flooding. Pp. vii + 274. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1948.) 36*s*. net.

Reviews of Petroleum Technology

Vol. 8 (covering 1946). Pp. viii + 445. (London: Institute of Petroleum, 1949.) 27*s*. 6*d*.

THERE has probably never been a time in the history of the oil industry when 'petrol', to use the colloquial term, has engaged so forcibly public attention in Great Britain and elsewhere. Once rationing is imposed on any commodity which has been taken for granted, as up to 1939 petrol certainly was and likewise food (water has always been), there is solid basis for the ordinarily complacent citizen to know the reason why and to bestir himself to the facts. Even to keep a ration going for vital needs in time of emergency and stress is a formidable task; had it not been for amazing advances in technique of producing motor fuels by processes developed during the Second World War and afterwards, one wonders whether, indeed, economic factors aside, the petrol ration would not be with us in Britain and in Europe generally for years to come.

The explanation of these advances is, of course, highly technical; it rests on the extraordinary rate of evolution in refinery procedure during the past decade and on conversion of petroleum in the more or less raw state into motor fuels by specialized thermal and catalytic processes. Dr. A. N. Sachanen devotes his large book to this complex subject and, to the technologist, shows how catalytic cracking, alkylation, thermal cracking, polyforming, and making petroleum gas into fuel by Fischer–Tropsch processes have contributed to the position now realized. Commercialization of relatively minor developments, for example, catalytic isomerization, hydroforming and dehydrogenation, are ancillary. The book is a thoroughly up-to-date treatise on these matters.

On the production side, to add to efficiency of winning crude oil under varying structural conditions, Park J. Jones has written a graphic account of the mechanism of gas and flooding to liberate supplies. This is Vol. 5 of an extensive review on petroleum production methods in different reservoirs, and is clearly the work of a specialist who can visualize the shape of, and fluid conditions obtaining in, oil-pools and can lay down precepts for making the most of the

two inseparable companions to petroleum, namely, gas and water.

With the third work here considered, "Reviews", the Institute of Petroleum resumes its annual publication covering in the main the year 1946, including chapters omitted from the previous volume (1941–45) published in 1947. The most important of these is the section on lubrication and lubricants. Here again, however, the whole field of production and the wide range of petroleum derivatives are covered by experts, whose knowledge of research trends in each branch of the industry is firm assurance that different readers' interests are well and truly documented and brought into the correct perspective of the times.

H. B. MILNER

COLORIMETRY IN CHEMICAL ANALYSIS

Colorimetric Methods of Analysis

Including Some Turbidimetric and Nephelometric Methods. By Dr. Foster Dee Snell and Dr. Cornelia T. Snell. Third edition. Vol. 2: Inorganic. Pp. x + 950. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1949.) 90*s*. net.

THIS second volume describes colorimetric methods of analysis for sixty-eight elements and compounds, a chapter being devoted to each, together with some turbidimetric and nephelometric methods. The authors in the preface point out the difficulty in the critical selection of procedures, stating that "when authors are highly critical, a book is correspondingly highly personalized and non-inclusive. When authors are uncritical, a book becomes a mere collection of methods." A survey of all papers relating to chemical analysis published in the year 1946 showed that 23 per cent related to the field of colorimetry, which emphasizes the difficulty in clearly indicating to the reader the most reliable methods.

In order to serve as a guide, the more important methods have been mentioned in an introductory portion to each chapter, and, where drinking water and sewage are concerned, the "Standard Methods for the Examination of Water and Sewage" of the American Public Health Association have rightly been given prominence. Methods which have been published as the result of collaborative study can generally be accepted as reliable without much further search of the literature; for example, in the United States, those of the Association of Official Agricultural Chemists in the U.S.A., or, in Great Britain, the Society of Public Analysts and Other Analytical Chemists. Methods which appear to have gained acceptance in the literature by a single contributor have frequently been too little studied, and errors may be pointed out some years after their original publication, as in Schoonovers's method for silver, using as a reagent *p*-dimethylaminobenzalrhodanine, recently criticized in this journal[1]. Original papers by more than two thousand authors are referred to in the volume, so that the reader will have no difficulty in tracing the source of the information given; but the analyst would be well advised to study the fundamentals of colorimetry, instruments, etc., which are given in Vol. 1 before proceeding with any particular colorimetric analysis, since the many pitfalls encountered in colorimetry cannot again be described in this Vol. 2.

Considerable care has been taken in the methods of preparation of a solution—from most of the complexes the analyst is likely to encounter—in a form suitable for colorimetry, the methods of eliminating interfering substances being given when known. These methods will vary from complex to complex, for, as stated by the authors in the chapter on phosphorus, "The distribution of small amounts of phosphorus is so wide—metals and alloys, minerals, biological samples—that there are necessarily correspondingly wide needs for methods". There can be few problems in the colorimetric determination of phosphorus which are not referred to in the fifty pages devoted to this element; similarly, silicon has necessitated a very wide survey. The determination of iron by the use of the *o*-phenanthroline reagent illustrates the factors which must be taken into account in varying circumstances. The authors have described the concentrations of extraneous substances which may cause interference, effects of temperature, *p*H, the order of adding reagents and the period of standing, and time intervals between addition of reagents.

The method of extraction of ferric chloride from aqueous solutions by ether in order to eliminate interfering substances, and a suitable apparatus for this, are described and illustrated. It would be of great help if all original papers on colorimetry would include details such as these. It is sometimes difficult to obtain reagents sufficiently free from the element to be estimated to ensure insignificant blanks. Chapter 1 gives directions for the elimination of lead from most of the reagents used, and, while it is too much to hope that this system can be followed universally, it would frequently be most helpful in highly critical work, where the blank may have a value as high as the substance estimated. The use of the reagent 'dithizone'—diphenylthiocarbazone—has increased so widely in recent years that early in the volume a short general article has been devoted to its use, so that the principles involved in its colorimetry can readily be understood in subsequent applications.

Many methods somewhat scantily treated in the previous edition on account of lack of full information now appear as well-tried methods; for example, the modern method for the determination of very small amounts of arsenic by the molybdenum blue colour has been placed on a sound footing. Although more complicated than the Gutzeit method, the evaluation of the final colour may be made by a photo-electric colorimeter, thus eliminating the uncertainty accompanying the visual judgment of the colour of stains on paper. The determination of traces of toxic elements in foods and biological specimens has generally been adequately dealt with; but there are omissions—for example, beryllium is mentioned only in connexion with ores and alloys. The recent use of Naphtho-chrome Green *G* is omitted, although its use eliminates many of the difficulties formerly encountered. The importance of what are usually termed 'trace elements' in soil has not been lost sight of, reference being made to most elements necessary for growth.

This volume is one to which frequent reference will be made by all who need colorimetric methods of analysis; the quality of the paper, binding and printing are of the type essential to a standard work of reference. The general arrangement of matter is logical, and directions to the analyst are clear and concise.

JOHN KING

[1] Allen, J. A., and Holloway, D. G., *Nature*, **166**, 274 (1950).

New Times, New Methods and New Men

By V. M. Clarke. Pp. 149. (London: George Allen and Unwin, Ltd., 1950.) 10*s.* 6*d.* net.

MRS. V. M. CLARKE is the personnel and administrative advisor to a large industrial undertaking and, in her book, sets out the principles on which she believes modern industry should be organised. These, she says, should be the basic principles of life—co-operation for service to the individual and to the community. This would entail a complete change of heart in which old prejudices will be swept away and, through inspired leadership, men would work for the common good in a spirit of selfless devotion. As a result industry, besides becoming more efficient, would not only enable men and women to live more abundantly but would also provide the conditions through which well-integrated and responsible communities could evolve.

Such is the theme of the book, and with it few will take exception. Where Mrs. Clarke may lose support, however, is that in her zeal the theme is too recurrent; instead of so much good advice about what needs to be done, industrial management would have welcomed some information about how it is proposed to bring about the changes of heart which would usher in the new industrial age. Instead of a plea for new leadership, for example, one would have preferred an analysis of the qualities of leadership and a statement of where and how leaders are to be found and developed. It is more than probable that the generalizations in this book will momentarily fan up the enthusiasm of the believer, but, with little added to his knowledge or understanding, leave him somewhat flat at the end; with the unbeliever they will leave him where he was before except, possibly, a little more suspicious and unbelieving. In many ways the style of this book belongs to a Tractarian age and would probably have gone nearer to fulfilling its purpose if it had been published in pamphlet form.

T. H. HAWKINS

Lezioni di geometria moderna

Per Beniamino Segre. Vol. 1: Fondamenti di geometria sopra un corpo qualsiasi. Pp. iv+195. (Bologna: Nicola Zanichelli, 1948.) 1200 lire.

IT is impossible to read this volume without comparing it with that of Hodge and Pedoe on the "Methods of Algebraic Geometry", and indeed the two make excellent companion volumes, each amplifying the other. B. Segre presents a somewhat broader account of various fields and processes; but his discussion of the basic algebra and of details is less deep.

While Hodge and Pedoe do suggest that there is another point of view for the fundamentals of algebraic geometry, the treatment of Segre admits only the one which renders the subject a handmaiden of modern algebra rather than that which renders algebra a handmaiden of geometry. To me, who regards the attitudes of such writers as Baker and Mathews with particular respect, this absence in a book on fundamentals of the possibility of correlation between the various basic points of view is felt as regrettable. To one whose normal attitude is fundamentally projective, the volume would have been easier to read if the author had at an early stage made a specific definition of his concept of geometry as a whole, and algebraic geometry in particular, instead of leaving it to be gradually assimilated from the development of the text.

In his introduction the author expresses needless modesty in referring to his index. The indexes and bibliography can well stand as a model to many authors.

H. GWYNEDD GREEN

A List of British Scientific Publications reporting Original Work or Critical Reviews

(Royal Society Information Services Committee.) Pp. 95. (London: Cambridge University Press, 1950.) 2*s.* 6*d.* net.

THIS booklet, issued under the imprimatur of the Information Services Committee of the Royal Society, lists scientific periodicals published in the United Kingdom containing a substantial proportion of original work or critical reviews, and includes also a number of the technological journals publishing original work. The extent to which the latter field is covered is rather indefinite, and there are a number of surprising omissions; for example, the *Journal of the Society of Dyers and Colourists*, the *Transactions of the Institution of the Rubber Industry* and the *Structural Engineer*; on the scientific side, the omission of the *Memoirs of the Manchester Literary and Philosophical Society* is doubtless an oversight. These omissions could be rectified in a second edition, when the principle of selection on the technological side might perhaps be made clearer.

The chief criticism to be made of the list in its present form is that an arrangement in alphabetical order under publishing organisations is not the most useful or convenient form for users, in spite of the inclusion of an index to the names of journals and a general subject index. The publishers' names would more appropriately have been collected in a separate index, and the periodicals would more usefully have been arranged alphabetically by title.

R. BRIGHTMAN

Synthetic Petrol

By Dr. S. L. Bhatia. (Indian Science News, 3.) Pp. xv+92. (Delhi: The Author, University of Delhi, 1950.) 2 rupees.

THE underlying theme of this booklet is that India is, like Great Britain, largely dependent on foreign countries for supplies of petrol, in her case Burma, Iraq, Iran, Arabia and Indonesia. Since the National Government of India was formed and "with the attainment of freedom", demand for petrol has increased. The object the author has in presenting the facts about synthetic petrol is to arouse the interest of laymen, manufacturers, chemists and engineers, to say nothing of the Government of India itself, to the vital importance of building up a key industry on national lines comparable with what has already been done in America, Britain, Germany and Japan.

The subject is dealt with by giving a brief history of the development of processes for producing synthetic petrol in the countries mentioned, discussing raw material involved (coal and hydrogen) and their chemistry, outlining the principal methods of manufacture of synthetic petrol (hydrogenation of coal and the Fischer–Tropsch process), concluding with a chapter on antiknock materials and knock rating of motor fuels, and also a bibliography. As a contribution to the "India at Work" series of publications, this little book will undoubtedly fulfil its author's intentions, but it is not exactly easy reading for the layman, perhaps others too, for whom it was written; it also suffers from being untidily printed.

LOCUSTS AND GRASSHOPPERS

A SPECIAL session, held on September 5, of Section D (Zoology) of the British Association at the Birmingham meeting was devoted to a symposium on the locust and grasshopper problem.

The subject was introduced by Dr. B. P. Uvarov, of the Anti-Locust Research Centre, who pointed out that the steady increase in world population makes it essential not only to grow more food, but also to protect crops from losses caused by insects. Before the Second World War, locusts and grasshoppers were estimated to cause an average annual loss of food crops to the value of some 15 million pounds; it would not be an exaggeration to double that figure now, owing to the rise in prices. Although this is the oldest entomological problem, it is still largely unsolved. In the past, its solution was hampered by the periodicity of locust plagues, which made it impossible to obtain support for continuous research. Since 1929, however, British anti-locust research has been organised on the basis of continuity, and of wide, if largely informal, international collaboration.

The locust problem has many aspects, its main ramifications being: causes of vast fluctuations in numbers of the insects; transformation of locust phases from a relatively harmless solitary phase to the swarming one; migrations over wide areas; effects of agricultural practices, etc. Modern developments in insecticides and machinery make locust killing a relatively simple technical operation; the difficulty is in the organisation, as local efforts are of little use owing to the mobility of the insects. Successful anti-locust campaigns were conducted during the Second World War in Africa and the Middle East, and their success was due to overall planning and co-ordination of the efforts of many countries; such efforts can be repeated, but they can achieve only temporary successes. In the case of grasshoppers in North America, chemical control is highly successful; but operations have to be repeated every year, at an ever-increasing cost.

All such successes are temporary, but a lasting solution of the problem is also possible. Investigations of the past twenty years have shown that locust plagues arise in some relatively restricted areas from which swarms gradually spread over whole continents. Such 'outbreak areas' have been defined in the case of two African locusts, and they are now kept under continuous observation and control by small international organisations. The initial stages of at least two plagues have been noticed in time and suppressed before they could develop. It is now hoped that a careful study of the conditions which favour the initial swarming in the outbreak areas may provide the means of preventing plagues by altering the conditions in a sense unfavourable to swarming. This may require long study and experiment, but the prospect of complete prevention of plagues is sufficiently attractive to justify the work. Thus, while the locust problem cannot yet be considered as solved, it is known to be soluble, and the way towards its solution is now fairly clear. Final success depends largely on the effective international organisation of both research and control, and the most promising form of international co-operation is offered by regional organisations, each concerned with a single species of locust and supported by all countries subject to invasions by that species.

With regard to research, Dr. Uvarov particularly insisted that the problem cannot be solved by entomologists alone, but requires their close collaboration with physiologists, biochemists, meteorologists, geographers and agronomists.

Dr. Peggy Ellis (University College, London) then presented a very lively account of her experimental work on movement in locust hoppers. In the field, hoppers of the gregarious phase are known to undertake spectacular marching in large bands, while those of the solitary phase spend most of the day resting on vegetation. It has proved possible to induce regular marching in cages and thus to study it experimentally. It was found that marching is favoured by medium temperatures (86–95° F.), radiant heat, air movement and absence of food in the cage; the effect of hunger was very pronounced. Marching activity is very much dependent on the density of hopper groups, suggesting mutual stimulation. Hoppers of the phase *solitaria* could be induced to march when placed in a group, but less persistently than gregarious hoppers. Although vigorous marching of starving hoppers in the field may increase their chances of finding food, they often march into the desert, and there is no evidence that marching is a quest for food.

Miss Z. Waloff (Anti-Locust Research Centre) followed with a review of recent work on locust migrations. Although locusts are known to have migrated in swarms in ancient times, their invasions have, until recently, been regarded as unpredictable. For the past twenty years, however, reports of swarm movements and breeding of three economically important species, the desert or Bible locust, the African migratory locust and the red locust, have been collected at the Anti-Locust Research Centre, London, where they are mapped and analysed. The cartographical analysis has led to the delimitation of their outbreak and invasion areas, of the seasonal distribution of breeding, which is closely linked up with the seasonal incidence of rain, and to the establishment of the fact that the directions of migrations follow definite seasonal patterns. On the basis of these findings, it is now possible to prepare generalized forecasts of the probable movements of swarms, and to warn threatened countries well in advance of the actual appearance of the swarms.

The establishment of the seasonal patterns of migration raised the problem of the factors to which they might be due, and in particular of those which affect flying activity and the direction of movement. Such information is required not only for understanding the phenomenon of migration, but also for short-range forecasting of swarm movements in connexion with the use of mechanized control methods carried out by mobile units against mobile winged locusts.

Recent field-work in Africa on the behaviour of desert locust swarms has shown that migration is greatly affected by current weather conditions. Sunshine has a profound effect on flying activity, and in its presence locusts are able to migrate actively at air temperatures at which, but for the sun, they would

be completely immobilized. The effect of solar radiation may be responsible for the ability of locust swarms to migrate in conditions as contrasted as those around the Red Sea in summer and the Moroccan highlands in winter.

The height at which locusts fly and the structure of the swarms are closely related to the intensity of thermal convection currents such as develop over heated ground and are known to provide a source of lift to soaring birds and sailplanes. In the absence of convection, flying locusts keep low above the ground and fly in flat stratiform swarms. When convection is present, the swarms resemble cumulus clouds and are described as cumuliform. When convection is vigorous, locusts may be lifted several thousand feet above the ground.

Not only the vertical convection currents but also the horizontal winds have an important transporting effect and affect the direction of movement. The flying speed of locusts is about 11 m.p.h., and at wind-speeds above this value the direction of displacement is down-wind regardless of the course on which the locusts fly. When winds are light, the direction of displacement is related to the course adopted by locusts, and there is evidence to suggest that wind is concerned in determining the direction of this course.

It is clear from field observations that the problems involved in diurnal movements and in large-scale geographical displacements cannot be solved unless equal attention is paid to locust behaviour and to the dynamic medium in which they move, and investigations on migrations call for close co-operation between entomologists and meteorologists.

Dr. J. S. Kennedy (Unit of Insect Physiology, Cambridge), in his address, concentrated attention on the problem of direction in migrations of the desert locust. The most characteristic feature of the behaviour of migrants is their persistent locomotion, and when one watches them pressing steadily on, they seem directed by some mysterious inner force. Nobody has taken this interpretation quite literally, but it has had the effect of turning the search for directing forces away from the environment of the migrants. Yet there is now sufficient evidence that flying locusts are by no means oblivious of their immediate surroundings, and that the individual's direction is continually being regulated by stimuli from other individuals, from the sun, the wind and so on. There is good reason to suppose the wind to be the key factor to the resultant long-range trends in migrations. It appears to have an important orienting and transporting action, depending on its strength and the height at which the insects are flying. The migrant seems to be making a complicated series of regulatory responses, probably visual; they are necessitated by the fact that the medium in which the locust carries out its persistent locomotion is the air, which itself moves. The success in this 'ding-dong battle' between insects and wind sometimes goes to the insects, when their movements have an up-wind tendency, and sometimes to the wind, when they go with it. A theory of how long-range directions may be determined can, therefore, be constructed, with the wind as the primary factor, while other factors, such as temperature and light, decide what kind of directing action the wind will actually exert at any particular time and place.

Dr. O. W. Richards (Imperial College of Science and Technology, London) dealt with the important problem of estimation of numbers in a grasshopper population. Working on British grasshoppers, it has been possible to develop techniques not only for estimating the total population, but also to follow changes in its age structure, mortality in different instars and so on.

In the discussion that followed, Dr. V. B. Wigglesworth (president of Section D) asked why the establishment of permanent control of the desert locust had been slower than that of the migratory and the red locusts. Dr. Uvarov explained that the area of the desert locust is very much larger and comprises some of the most inhospitable regions, many of them difficult of access for physical and political reasons. This area extends over some twenty-five countries, with governments so widely different that it is almost impossible to arrange for satisfactory co-operation. The result is that, while the other two locusts are under control, a new plague of the desert locust is actually developing; this may provide a salutary lesson to those countries which have so far failed to see the advantages of common action.

Prof. G. C. Varley (Oxford) suggested that an evolutionary approach to the migration problem might provide valuable clues, but Dr. Uvarov maintained that it is best to start by studying the phenomenon in all its aspects, rather than by theorizing while factual knowledge is still inadequate.

Captain T. Dannreuther provided some examples of long-range migrations by Lepidoptera which, in his opinion, cannot be explained by reference to climatic factors; Miss Waloff suggested, however, that such cases might usefully be analysed against synoptic weather data. B. P. UVAROV

CHEMICAL COMPOSITION OF NEWLY BORN MAMMALS

By E. M. WIDDOWSON

Medical Research Council Department of Experimental Medicine, Cambridge

THE chemical composition of the fœtal and newly born mammal has interested many investigators in the past hundred years, but no one ever appears to have made a direct comparison of the full-term human baby with the newly born of other mammalian species. Von Bezold[1,2], who was the first to make a chemical analysis of a human fœtus, is, in fact, the only one who has analysed both human and other species, and his human fœtus weighed only 523 gm.

As part of a study of some chemical aspects of growth, six full-term human babies[3] and a number of newly born mice, rats, rabbits, guinea pigs, cats and pigs have been analysed. One grey seal (*Halichœrus gryphus*) was also investigated. This was found dead

Table 1. Water, protein and fat in newly born mammals

Species	No. analysed	Average weight gm.	gm. per 100 gm. fresh weight		
			Water	Protein	Fat
Human	6	3,564	69·1	11·9	16·1
Pig	16	1,460	84·1	11·3	1·1
Cat	5	118·0	80·7	14·9	1·8
Rabbit	12	54·0	84·6	11·1	2·0
Guinea pig	10	80·1	70·9	14·9	10·1
Rat	68	5·85	86·0	10·8	1·1
Mouse	68	1·55	83·3	12·5	2·1

Table 2. Composition of newly born mammals on a fat-free basis

Species	Human	Pig	Cat	Rabbit	Guinea pig	Rat	Mouse
Water, gm. per 100 gm.	82·3	85·1	82·2	86·5	78·9	87·0	85·0
Protein ,, ,, ,,	14·1	11·4	15·2	11·3	16·5	10·9	12·8
Na, mgm. per 100 gm.	226	241	231	243	173	236	226
K ,, ,, ,, ,,	205	209	222	206	250	208	274
Ca ,, ,, ,, ,,	955	999	661	484	1,131	306	340
Mg ,, ,, ,, ,,	26·0	31·9	26·1	23·4	41·4	25·1	33·6
P ,, ,, ,, ,,	558	575	436	361	741	356	343
Fe ,, ,, ,, ,,	9·39	2·92	5·54	13·50	6·68	5·86	6·65
Cu ,, ,, ,, ,,	0·47	0·32	0·29	0·40	0·69	0·43	0·67
Zn ,, ,, ,, ,,	1·92	1·01	2·87	2·25	3·50	2·44	4·64

on a beach on the Isle of Oronsay, Scotland, and was judged by Dr. F. Fraser Darling to have been newly born. Further information about the material, the preparation for analysis and the chemical methods involved are given in forthcoming papers by Widdowson and Spray[3,4].

Table 1 shows the composition of the newly born animals in terms of protein, fat and water. It will be seen that the outstanding variable in the composition of the newly born mammal is the fat. The mouse, rat, rabbit, cat and pig contained only 1–2 per cent, the guinea pig about 10 per cent, and the human babies 16 per cent. The values for the individual infants varied from 11–28 per cent. The seal had 9 per cent. As long ago as 1911, Karl Thomas[5] directed attention to this variability in the proportion of fat in different mammals at birth, and he believed that those species which are born fat can regulate their body temperatures at birth, while those which contain only 1 or 2 per cent of fat are poikilothermic for the first few days until they have laid down sufficient fat to insulate their bodies against excessive heat loss.

The species which had the most fat were those which contained least water. In the newly born animals which contain so little fat, not only is there little or no subcutaneous fat, but the other fat depots of the body, for example, the bone marrow, are also almost fat-free. The bones of one newly born pig were analysed separately from the rest of its body and they contained 0·7 per cent of fat. A litter mate, analysed when it was three weeks old, had 7 per cent of fat in its skeleton.

The newly born guinea pig and human baby may contain a higher proportion of fat than their own mothers. The mothers of the newly born guinea pigs analysed in this investigation were themselves analysed and were shown to contain only 3·6 per cent of fat. It is well known that a thin woman can produce a very fat baby, and four examples taken from hospital records may be quoted. The women weighed 50·5, 52·0, 55·0 and 57·5 kgm. one week after the birth of their babies, and measured 161, 166, 173 and 176 cm. respectively. They had babies weighing 4,300, 4,280, 4,100 and 4,250 gm. at birth. The mothers probably all had less than 20 per cent of fat in their own bodies[6]; it is likely that their babies all had more than 20 per cent[3].

The variation in the proportion of fat in newly born animals is remarkable. Most of the fat in the human fœtus is deposited during the last weeks of intra-uterine life; but the process starts at about the end of the sixth month, when the fœtus weighs 800–1,000 gm.[3]. The differences between the various species cannot be related to the state of maturity at birth for, of the mammals studied, the pig and guinea pig are undoubtedly born most mature; one contains 1 per cent of fat and the other 10 per cent. There may, however, be some connexion between the large amounts of fat in the human, seal and guinea pig at birth and their comparatively long gestation periods. It is possible that in these species the supply of nutrients is greater than the rate of growth demands.

Table 3. Distribution of Fe, Cu and Zn in the bodies of newly born mammals

	mgm. per 100 gm. of liver and spleen			Percentage of the body's Fe, Cu and Zn present in liver and spleen		
Species	Inorganic Fe	Cu	Zn	Inorganic Fe	Cu	Zn
Human	22·1	4·2	7·0	14	44	23
Pig	8·5	5·4	3·0	8	48	8
Cat	23·2	2·0	15·0	23	40	28
Rabbit	84·5	2·8	9·3	33	38	22
Guinea pig	4·1	5·1	4·3	5	58	9
Rat	14·8	2·0	9·9	17	30	27
Mouse	16·0	4·7	19·9	14	40	36

Some work of Boyd[7] and Boyd and Fellows[8] offers another possible explanation. These authors were interested in the lipæmia which occurs during pregnancy in humans and guinea pigs, but not in rats or rabbits. Boyd[9] and Boyd and Wilson[10] suggested that this lipæmia in the mother's circulation created

Table 4. A comparison of the composition at birth of the largest and smallest pigs in three litters

	Litter *Q* (13 in litter)		Litter *S* (11 in litter)		Litter *T* (12 in litter)	
	Largest ♂	Smallest ♂	Largest ♀	Smallest ♀	Largest ♀	Smallest ♂
Weight gm.	1,236	472	1,331	890	1,448	1,035
Water gm. per 100 gm.	83·9	85·9	84·3	86·0	84·9	86·8
Protein ,, ,, ,, ,,	12·0	10·2	11·7	10·0	11·0	9·0
Fat ,, ,, ,, ,,	1·17	0·85	0·89	0·69	0·89	0·53
Na mgm. per 100 gm.	266	266	241	245	232	220
K ,, ,, ,, ,,	215	190	210	192	213	186
Ca ,, ,, ,, ,,	885	900	960	945	850	1,010
Mg ,, ,, ,, ,,	27·8	31·0	31·6	29·4	26·7	36·8
P ,, ,, ,, ,,	473	493	500	578	513	603
Fe ,, ,, ,, ,,	3·28	3·13	3·48	2·63	2·62	2·66
Cu ,, ,, ,, ,,	0·38	0·36	0·33	0·27	0·30	0·24
Zn ,, ,, ,, ,,	0·94	1·08	0·88	0·90	0·77	0·85

some measure of lipæmia in the fœtus, and they estimated that at full term the average large, well-nourished infant absorbed 40–50 gm. of lipoids per day from umbilical blood, 75 per cent of this being phospholipids and the remainder free cholesterol and cholesterol-esters. Boyd and his co-workers did not relate the lipæmia of the mother to the percentage of fat in the newly born animal; but it is significant that two species which exhibit the lipæmia should be two the young of which are 'fat' at birth. The rat, rabbit, guinea pig and human all have placentæ of the hæmochorial type; but the first two, which get no lipæmia during pregnancy, give birth to young containing only 1–2 per cent of fat, although it has been shown that their placentæ are permeable to fat[9,11,12,13]. No work appears to have been done on the passage of lipoids through endothelio- or epithelio-chorial placentæ; but Gortner[14] has made a study of the lipid fractions in the body of the fœtal pig and has shown that the percentage of total lipid remains constant for a large part of embryonic life.

Table 2 shows the percentage composition of the newly born animals on a fat-free basis. The guinea pig, the most highly developed at birth, contained the most protein, calcium, phosphorus and magnesium, and this was one of the two species which had more potassium than sodium in its body. The newly born human also had comparatively high concentrations of calcium and phosphorus, and so did the pig and the seal. The last contained 1,088 mgm. calcium, 648 mgm. phosphorus, 39·6 mgm. magnesium and 2·88 mgm. zinc per 100 gm. of fat-free body tissue.

Hair is rich in zinc[4], and the guinea pig, kitten and seal, which are covered with hair or fur when they are born, contained more zinc per 100 gm. than the rat, rabbit, pig or human. The mouse had more zinc than any of the other species, and this is more difficult to explain; three separate batches of newly born animals were analysed with the same result. The mouse was also peculiar in that, although it is born in a very immature state, it had a very high concentration of potassium.

The liver of the newly born rabbit contained 84 mgm. of inorganic iron per 100 gm. (Table 3), which was four times as much as the liver of the newly born of any of the other species; and one-third of the iron in the rabbit's body was in its liver. Bunge's[15] thesis that the young mammal is born with enough iron stored in its liver to tide it over the suckling period was based on his work on the rabbit, which is an exceptional animal in this respect. In spite of all the iron in its liver, however, the rabbit suffers from a typical suckling anæmia, for little of the iron seems to be utilized for blood formation[16].

The pig and guinea pig, which are born with a particularly small amount of iron in their livers, have the most copper, and the seal, mouse and kitten the highest concentrations of zinc. If these metals are stored in the liver on the same proteins, the presence of a large amount of one may inhibit the storage of another. In all the species the liver contained a higher proportion of the body's copper than it did of either its iron or its zinc.

Venn, McCance and Widdowson[17] showed that newly born piglets from the same litter had very much the same concentration of iron in them, although they varied greatly in size. Complete analyses of the largest and smallest piglets in three litters have been made, and the results are given in Table 4. In each case the smaller animal of the pair had a lower concentration of protein and fat, and a higher proportion of water. It also contained less potassium, all of which would suggest that it was not quite so mature. On the other hand, two of the small animals contained more calcium and magnesium per 100 gm. than their larger litter mates, and all of them had a higher proportion of phosphorus and zinc.

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ESTIMATION OF RADIOACTIVE HYDROGEN (TRITIUM)

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THE similarity of the exchange characteristics of deuterium and tritium, together with the ease of deuteration of many organic compounds, suggest that tritium will be a valuable biological tracer. Tritiated metabolites can be detected in much greater dilutions than the same compounds labelled with deuterium. Introduction of tritium into organic molecules by exchange or other simple reactions may obviate many of the difficult micro-syntheses necessary with carbon-14. The methods of estimating tritium, however, have not been suited to routine assay in biological experiments.

Tritium has been estimated as water vapour added to gases known to be suitable as Geiger counter-fillings. In this method spurious counts at high water-vapour tensions limit the weight of water which can be included in the counter. According to data given by Kamen[1], only 1 mgm. of water can be assayed in a counter of 200 ml. capacity. In many biological experiments, however, it is necessary to estimate low specific activities, and it is therefore desirable to have a method which estimates the tritium content of water samples of the order of 50–100 mgm. In addition, it is difficult to decontaminate counters which have contained THO [2].

The vibrating-reed electrometer[3], or sensitive Lauritzen electroscope[4], together with ionization chambers, can be used for tritium estimation. With ionization chambers, however, the isotope is usually assayed as hydrogen gas, necessitating a reduction of the water formed by combustion of metabolites. Water has been reduced with metallic sodium under vacuum[5], or by heating to 400–600° C. with mag-

nesium metal or amalgam[4,5]. The tediousness of the reduction procedures and the reported difficulties of decontamination of the apparatus limit the usefulness of these methods for routine assay.

Hydrogen as prepared above has also been assayed for tritium content in gas mixtures in Geiger counters[3]. Although 12 mgm. of hydrogen can be included in a 200-ml. counter, low accuracy (15 per cent) results from the poor counting properties of hydrogen.

Methane is a good filling for Geiger and proportional counters. Water reacts rapidly with aluminium carbide at room temperatures to give impure methane, containing small amounts of hydrogen, oxygen, ammonia, hydrogen sulphide and unsaturated hydrocarbons[7]. The counting characteristics of the gas produced by the action of tritiated water on aluminium carbide have been investigated. Deuterium oxide reacts at a slow rate with aluminium carbide below 65° C.[8], and the reaction with THO was therefore done at 100° C.

0·3 ml. tritiated water was placed in the 'Pyrex' reaction vessel *A* shown in Fig. 1. The water was frozen by immersing the lower end of the vessel in a dry-ice–acetone mixture. Approximately 2 gm. of finely powdered aluminium carbide was added and the vessel evacuated to a pressure of less than 10^{-2} mm. mercury. The vessel was heated to 100° C., and the methane then partially purified by immersion in a dry-ice–acetone mixture for one hour.

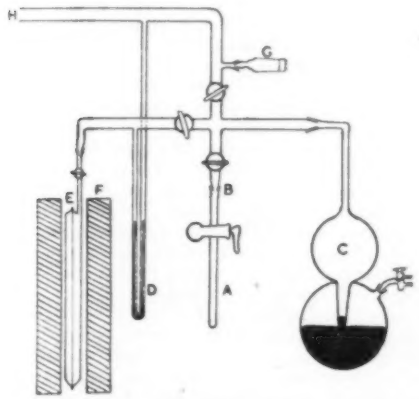

Fig. 1. Apparatus for estimation of tritium in tritio-methane. *A*, 'Pyrex' reaction vessel; *B*, cone joint for attachment of reaction vessel; *C*, Toepler pump; *D*, mercury manometer; *E*, *GA*26 Geiger-Müller tube; *F*, 2-inch lead screen; *G*, Pirani gauge; *H*, pump line

Activities were measured in the apparatus shown in Fig. 1. The Geiger–Müller tube used was a 200-ml. type *GA* 26* glass-walled counter with a carbon cathode. The reaction vessel was attached to the cone joint *B* and the apparatus evacuated to a pressure of less than 10^{-3} mm. mercury. By means of the Toepler pump *C*, the methane was then pumped into the counter to the required pressure as measured on the manometer *D*.

The impure methane was found to have no usable Geiger region; this result must be attributed to impurities.

The proportional region is known to be less sensitive to impurities and was therefore next investigated. Pulses from the counter were amplified with an

* Obtainable from 20th Century Electronics, Ltd., London.

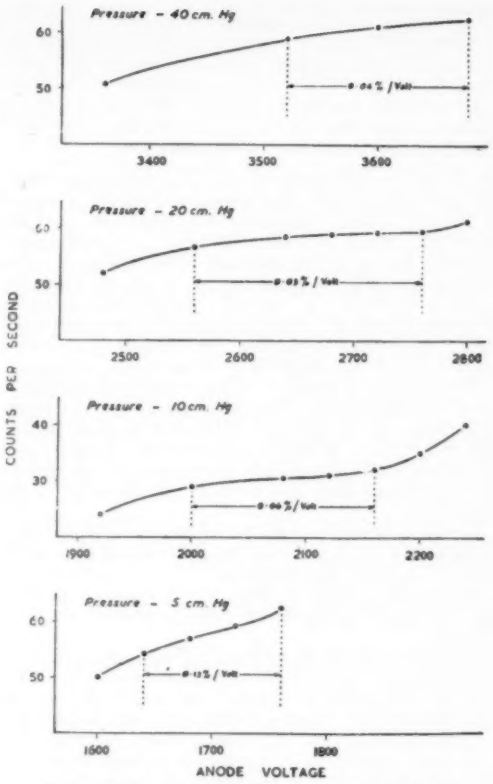

Fig. 2. Plateaux of tritio-methane in proportional region

amplifier (Type 1008) and were recorded on a scaler (Type 200) after passing through a discriminator (Type 1028) for rejection of noise and pick-up. Stabilized anode voltages were supplied by a power unit (Type 200) via a ripple filter and a 5-MΩ anode load. The pulses were passed to the amplifier via a 0·001 μF. condenser. A 25 kV. T.C.C. $CP_{57}A$ non-ionizing type condenser was used here, as some other types of condenser were found to give spurious counts due to ionization in cavities in the dielectric. A gain of 4,000 has been used on the amplifier in most experiments.

Fig. 2 shows typical plateaux in the proportional region of methane formed by the action of tritiated water on aluminium carbide. At 20 cm. mercury pressure of methane the usable plateau extends for 300 volts and has a slope of 0·03 per cent per volt

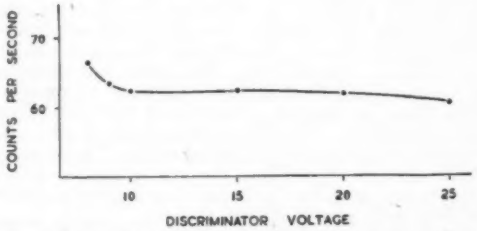

Fig. 3. Relationship between recorded pulse-rate and discriminator bias for sample of tritio-methane at 20 cm. mercury pressure

RELATION BETWEEN TIME OF REACTION AND ACTIVITY OF TRITIOMETHANE

Reaction time in hours	Counts per second of sample in counter at a pressure of 20 cm. Hg.
½	23·7 ± 0·2*
¾	24·2 ± 0·2
1	24·0 ± 0·2
16	25·9 ± 0·2

* Errors shown are standard errors

for a range of 200 volts, so that high tension need not be highly stabilized. At a pressure of 20 cm. mercury a 200-ml. counter contains 9·4 mgm. of methane hydrogen, which is a suitable weight for estimations in many biological experiments. The counter is quite usable, however, at pressures up to 40 cm. mercury.

Fig. 3 shows a typical relationship between recorded pulse-rate and discriminator bias, affording proof of almost complete registration of ionizing events within the sensitive volume of the counter.

The period of reaction of the water and carbide at 100° C. was varied. The accompanying table shows that rates of reaction of THO and H_2O at 100° C. are not widely different. A reaction time of one hour is usually employed, since heating for shorter periods leaves droplets of water on the sides of the vessel.

Tritium activities can be estimated with a reproducibility of 2–3 per cent by pumping the methane into the counter to a pressure of 20 cm. mercury and counting at a single voltage. The voltage is determined for each Geiger-Müller tube by inspection of the plateau.

It is difficult to decontaminate apparatus used for reduction of tritiated water to hydrogen[1]. With the present procedure no contamination of the counter manifold or the reaction vessels has been detected.

During the action of tritiated water on aluminium carbide some tritium will combine to form aluminium tritio-hydroxide. The ratio of radioactivity in methane to total radioactivity in the water was therefore determined. A sample of tritiated water was reduced to hydrogen by heating to 400° C. in the presence of magnesium amalgam[4]. The hydrogen was then mixed with inactive methane in the proportion of 3 cm. of hydrogen to 17 cm. methane. The plateau of this mixture in the proportional region was quite usable although inferior to that obtained with methane. By this method it was found that approximately 50 per cent of the tritium in water allowed to react with aluminium carbide passes into methane. Since incomplete reduction of the water might have allowed isotope separation to occur, the reaction with magnesium amalgam was done for one-hour and four-hour periods, but without significant difference in the results.

With previous procedures it has been recommended that water samples be purified by repeated distillations *in vacuo* before reduction to hydrogen[1]. Purification has been found to be unnecessary with the present method. A whole rat was blended, and the homogenized tissues oven-dried and combusted to water by heating in a stream of oxygen passing over red-hot copper oxide. The water was collected in a U-tube immersed in dry-ice, and no precautions were taken to prevent collection of impurities from the combustion. The water thus obtained was used for diluting a sample of tritiated water. The counting characteristics of methane derived from the diluted sample were found to be the same as those of methane derived from pure tritiated water.

With a two-inch lead screen and methane at 40 cm. mercury pressure, the background of the counter was found to be 1·7 counts per second, so that samples having an activity as low as 1 count per second can be estimated. The method thus allows assay of material having a specific activity of $1·5 \times 10^{-6}$ C. per mgm. of hydrogen.

We would like to thank Prof. B. S. Platt for his interest in this work. Thanks are also due to the Atomic Energy Research Establishment, Harwell, for provision of the tritium and loan of certain electronic equipment.

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REHABILITATION OF DERELICT LAND

'DERELICT LAND' has been defined as "land which has been so damaged by extractive or other industrial processes that in default of special action it is unlikely to be effectively used again within a reasonable period and may well be a public nuisance meantime". The existence of many thousands of acres of such land—exactly how much, no one has ever calculated—in this small and crowded island of Britain creates problems of considerable magnitude. These problems are national, in the sense that every acre of agricultural land is precious, and we cannot afford either to waste agricultural land by leaving it derelict after mineral working, or to condone the encroachment by other forms of 'development' on agricultural land while the derelict areas remain unused. The problems are also, and in a much more obvious sense, local, involving considerable land-use conflicts and questions of amenity.

A recent publication by R. O. Whyte and J. W. B. Sisam, entitled "The Establishment of Vegetation on Industrial Waste Land"[1], has summarized a large body of very scattered literature on the subject, drawn mainly from Britain and the United States; and a symposium on "Rehabilitation of Derelict Areas", held on September 5 in Sections K (Botany) and M (Agriculture) of the British Association during the recent meeting at Birmingham, shed considerable further light on recent progress.

There are really two quite distinct sets of problems involved: first, following the contribution of Prof. S. H. Beaver to the symposium, there is derelict land of the type that has characterized most of the older coalfield areas of Britain for many years past—land worked over for coal and perhaps also for ironstone, and scarred by pit-mounds, subsidence hollows, slag heaps from old ironworks; and other industrial waste. It is in the Black Country of south Staffordshire and north Worcestershire—a rough quadrilateral bounded by Walsall, Wolverhampton, Stourbridge, Halesowen, and West Bromwich—that this type of surface is most in evidence: a survey made in 1945 revealed more than 9,000 acres[2]. A surface of 'hills-and-hollows' resulting from the shallow mining of thick coal seams and numerous ironstone courses is the

most characteristic, with relatively few large individual spoil heaps and relatively few slag heaps (for despite the large number of furnaces during the nineteenth century, most of their slag has been quarried away for road metal). Since coal-mining has been virtually extinct in the Black Country for upwards of half a century, an appreciable vegetation cover, recently studied in detail by Dr. W. J. Rees of the University of Birmingham, has developed, and many of the areas are by no means unpleasant to the eye—though they are often made less attractive by the indiscriminate dumping of miscellaneous domestic and other refuse. Similar conditions obtain in the Shropshire coalfield (the Ironbridge–Oakengates area). To a certain extent, too, comparable circumstances exist in other coalfields, though here—as in the Potteries, for example, or in south Lancashire, in west Durham, and in the north-eastern part of the South Wales coalfield—the problems are of a rather different nature, partly since much of the mining was deeper, and the spoil heaps consequently larger, and partly because nowhere outside the Black Country is derelict land so concentrated and in quite such intimate relationship to urban development.

The rehabilitation of derelict areas in the Black Country must almost inevitably be in terms of levelling for housing and industrial sites, or for playing fields and recreation grounds. The creation of agricultural land is clearly out of the question in such an environment, while tree-planting, mainly of deciduous trees, since conifers suffer from the excessive soot deposit, can at best be merely for ornamental purposes. A few small plantations exist, and there are several well-maintained parks (notably Willenhall Memorial Park) created out of old spoil heaps. The reclamation of derelict land is no new thing in the Black Country. Many of the housing and industrial developments of the twentieth century have involved building on land which has been both undermined and covered with spoil. But with the advent of the bulldozer in the mid-1930's, and more recently the tractor-drawn scraper, the task of the civil engineer has been made much easier. A revision of the 1945 survey, carried out for the West Midland Plan in the early part of 1948, showed that in three years some 1,900 acres had been or were being reclaimed, while a further 400 acres of derelict land had been acquired by the local authorities for purposes of development—mainly temporary or permanent housing[3]. It is indeed a matter for great satisfaction, and reflecting credit on the eighteen local authorities concerned that, without any of the government money which has been specially available for reclamation in the so-called 'Development Areas', the problem has been so vigorously tackled.

Of an entirely different nature is the problem of the derelict surfaces created by the mechanization of certain types of quarrying operations, especially gravel digging in many parts of the country, and the excavation of ironstone in the East Midlands. The former is at present under consideration by a committee appointed by the Minister of Town and Country Planning. Several reports have been published[4], and some aspects of the problem have also been discussed independently by two members of the committee[5]. Opencast ironstone mining, to which has been added, during the past decade, opencast coal mining, has also excited considerable public interest, especially in Northamptonshire, where the greatest damage has been done; two official documents are available[6,7], with a third emanating from the industry[8], while two standing conferences, under the auspices of the Ministry of Town and Country Planning, are still at work discussing the ways and means of restoration and after-treatment.

In the symposium at Birmingham, these problems were surveyed in general terms, with special reference to the conservation and reconstruction of soil, by Sir John Russell, while Mr. R. B. Beilby, of Stewarts and Lloyds, dealt with the nature of the excavating machinery and of the surfaces produced; Mr. W. Morley Davies, of the Agricultural Improvement Council, considered the methods of bringing back devastated land into agricultural use, and Mr. R. W. B. Newton analysed the problem of afforestation.

The use of excavating machinery in the ironstone fields goes back to 1895, but there was little intensive development until after the First World War. It is often forgotten that since the early 1850's, when ironstone digging began in Northamptonshire, at least 10,000 acres of the mineral field have been restored to agriculture or developed in other ways, after the extraction of the ore. This was relatively easy when both ore and overburden were dug by hand, and surface soil could be replaced behind the advancing quarry face. Mechanical excavation and dumping of more than 30 ft. of overburden—and up to 90 ft. is now removed in one area—have created some 4,600 acres of derelict 'hill-and-dale', while a further 900 acres of such land has been afforested. Some 350 acres of ironstone-bearing land is now being worked each year, and the requirement for the next twenty years has been estimated at 12,800 acres. The excavators get bigger and bigger, the amplitude of the 'hill-and-dale' increases, and there is less and less economic possibility of separately removing and conserving the 'topsoil'. Until recently, the largest machines were face-shovels equipped with 9-cu. yd. buckets; the latest giant is a dragline excavator with a 282-ft. boom and a 20-cu. yd. bucket, and even larger ones are contemplated. It is true that the smaller types of 'walking dragline', operating in relatively shallow overburden of up to 35 ft., can avoid the creation of 'hill-and-dale' by casting their spoil to form a more or less level surface, but the possibilities in this direction are somewhat limited. A further very difficult problem is created by the quarries in which a large proportion of the overburden consists of the hard "Lincolnshire Limestone" formation. The 'hill-and-dale' in these circumstances is made up largely of limestone boulders, and is very difficult either to afforest or to level for agriculture.

Much has been done in Northamptonshire, by landowners and by the ironstone producers, to afforest the devastated areas; the largest firm in the field maintains its own tree nurseries and staff of foresters, and much experience has been gained. Much of the plantation has been of softwood species, notably larch and pine (and the Corsican pine seems best able to tolerate the atmospheric conditions which often prevail in areas near the iron and steel works); but hardwood trees, notably sycamore, alder, poplar and oak, have also been successful. There is in general no need to level the 'hill-and-dale' before planting; but it is important to drive level rides across plantations to facilitate planting and extraction. Rabbit-proof fencing is, of course, essential.

The reinstatement of agriculture on the devastated areas is more difficult, especially when, as is usual, the surface layers of soil and subsoil have been irretrievably lost and buried during the excavating

process. The civil engineering side of the problem—it may be called simply 'muck-shifting'—presents few difficulties, with modern draglines, scrapers and bull-dozers. There will, of course, be troubles arising from the uneven settlement of the levelled land, from defective drainage, and from the presence of boulders at the surface; but the major difficulty, as Sir John Russell pointed out, is the creation of a new soil out of what is virtually unadulterated rock, devoid of humus and of organic life, with no crumb-structure, and deficient in many of the chemical elements which contribute to plant growth. Much experimental work has been carried out in recent years by the ironstone producers and by the Ministry of Agriculture on levelled surfaces of different geological constitution, in order to ascertain the most appropriate methods of cultivation, pioneer and subsequent crops, and fertilizers. The fertilizers required naturally vary with the geological nature of the rock which now forms the surface, but usually there are marked deficiencies of phosphate, potash and nitrogen. The most useful pioneer plants are lucerne and clover, while of the grasses, ryegrass, cocksfoot, timothy and meadow fescue have all been grown with success; even wheat has been grown in the third year after restoration. A most striking fact is the complete absence of weeds—a great contrast with areas in which the soil has been conserved and replaced!

In opencast coal excavations, agricultural restoration, with replacement of soil, has been practised from the very beginning, with variable results. The economic circumstances, however, are rather different from those of the ironstone industry. Nevertheless, it is interesting to note that a recent Order by the Minister of Town and Country Planning has made soil conservation and agricultural restoration compulsory in all ironstone quarries in which the overburden consists of less than 35 ft. of material which is not mainly limestone—though it must be admitted that such quarries are relatively few in number, and that in many of them, as in Oxfordshire and in south Lincolnshire, agricultural restoration has in any event been customary since the quarrying began.

One vital matter, which was not mentioned by any of the speakers but which emerged during the discussion, is that there is a financial side to all these problems. Someone has to pay for the levelling and other after-treatment of derelict and devastated land, and it is by no means easy to see who should foot the bill. As Sir John Russell, Prof. Dudley Stamp and others have repeatedly reminded us, however, our one ultimate asset is our land, and it is our duty to hand down this heritage to future generations in a utilizable and not in a derelict condition.

S. H. BEAVER

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PARSONS MEMORIAL WINDOW IN WESTMINSTER ABBEY

AFTER the death in 1931 of Sir Charles Parsons, the Royal Society set up a committee to arrange an appropriate memorial of which a memorial window in Westminster Abbey was to be one part. Another is the Parsons Memorial Lecture delivered annually. A third was the contribution of £10,000 towards the Parsons Memorial Library at London House, Bloomsbury, which was opened by Their Majesties the King and Queen on December 3, 1937. The suggestion for a memorial window was favourably received by the Dean and Chapter of the Abbey, and it was agreed that its execution should be delayed for some years. The window has now been completed, to the design of Sir Ninian Comper, and was dedicated by the Dean of Westminster on October 5, on the invitation of Sir Robert Robinson, president of the Royal Society, before a large gathering including many members of the Parsons family and representatives of the Royal Navy and of the scientific and professional bodies and industrial concerns with which Sir Charles Parsons had been associated.

It is in the north side of the nave, next to that commemorating the engineer John Wolfe Barry, and near neighbours are those to Benjamin Baker and Lord Kelvin.

The memorial oration was delivered by Sir Frank Smith, chairman of the Royal Society memorial committee and himself the first Parsons Memorial Lecturer. Sir Frank sketched Parsons's early life and unusual upbringing as the sixth son of the third Earl of Rosse, who built in his own home at Parsonstown, Ireland, his famous reflecting telescope. He continued:

"The eighteen eighties were critical years for Parsons. They were also his years of triumph. At that time the gas engine was challenging the supremacy of steam in prime-movers. The generation of electricity by dynamos together with the ease of its transmission threatened the methods then in use for transmitting power. . . . In this maze of prime-mover problems and power transmission systems Parsons saw a great opportunity to solve both problems by developing an efficient rotary steam engine or turbine coupled directly to a high-speed dynamo. In this way he believed that steam would maintain its supremacy and that electricity would be generated at a reasonable price. To use his own words: 'I determined to attack the problem of the steam turbine and of a very high speed dynamo and alternator to be directly driven by it'.

"In choosing this objective Parsons was, I think, inspired by three main influences: the first and greatest was his love of attempting what others thought impossible; the second was his extraordinary knowledge of thermodynamics; and the third, his ambition to produce an economic rotary steam engine.

"A rotary steam engine was no novelty, but in practically all such machines the steam after expansion was ejected in a hurricane of vapour from which only a small part of the energy had been extracted. When allowed to expand freely high-pressure steam develops enormous velocities, and it was easy for Parsons to calculate that a turbine blade tip would need to move with a velocity exceeding that of sound to extract most of the energy from such steam. This was the first obstacle to be overcome. After a vast

amount of theoretical and experimental work, Parsons solved the problem by causing the steam to fall in pressure in a series of steps, each step being an elemental turbine. On these lines Parsons built his first compound steam turbine.

"The shaft of this turbine made 18,000 revolutions per minute and the development of a dynamo to work at this high speed was Parsons's next task. He overcame difficulties which many thought insurmountable and soon Parsons achieved his first objective; the first turbo-electric generator in the world was built and proved a success. A few years afterwards, four turbo-electric generators were supplied to the Newcastle and District Electric Lighting Company, and the modern electric power industry may be said to have started with those four engines.

"In these early turbines the steam after expansion was discharged into the atmosphere, but Parsons realized from the outset that the addition of a condenser would greatly increase their efficiency. Condensing turbines were constructed and these, in addition to other advantages over the reciprocating engine, were found to use less steam per horse power. Parsons's dream of the conquest of the reciprocating engine was complete. The first milestone in his astonishing career of progress was passed.

"While the development of turbo-generators was a great engineering triumph, that of the steam turbine for propelling ships was more dramatic. . . . With a boldness that amazed everyone he planned and built a small vessel only 100 ft. in length which he named the *Turbinia*. Its hull, propeller and engines were all designed by him. He relied entirely on his own knowledge and the results of his own researches. There were many serious setbacks, but as usual Parsons overcame them all. The *Turbinia's* speed was demonstrated in a striking way at the Royal Naval Review at Spithead in 1897 in honour of the Diamond Jubilee of Her Majesty Queen Victoria. . . . Soon afterwards the Admiralty ordered two destroyers with steam turbines and in a few years the superiority of the steam turbine for naval purposes was established beyond doubt. Parsons had conquered again. The second milestone was passed. . . .

"Parsons had many other pursuits and many more triumphs. He experimented with rockets to propel torpedoes; developed a loud-speaker which was used at concerts; experimented with model flying machines; investigated, designed and manufactured large searchlight mirrors; erected the first closed-circuit water tunnel for investigating the effect of cavitation on ships' propellers; made large reflectors for astronomical telescopes and started to make diamonds. . . .

"To me his outstanding characteristics were his insight into the mechanisms of Nature, his wonderful engineering knowledge, his great experimental ability and his amazing courage in face of technical difficulties. He never admitted defeat. His achievements were universally recognized. Scientific and technical societies loaded him with honours and His Majesty the King conferred on him the Order of Merit, the first time this honour had ever been given to an engineer. . . .

"Only once did I hear him refer to religious matters. This was after attending with him a service in the little wooden church at Fort Victoria in Southern Rhodesia. Parsons much enjoyed the service and afterwards entered into animated conversation with the preacher. Referring to the congregation, he remarked that country people and others living far away from great towns are always more religious than the inhabitants of great cities. It should not be so, he said. In towns the minds of men are apt to get too concentrated on things shaped by man, the radio, aeroplanes, motor-cars and the cinema. There are too few, said Parsons, who can visualize in these and other utilities, the mysterious mechanisms of the Creation, such as the movements of electrons, the marvellous motions of molecules in steam and the wonderful mechanisms of light and colour. Yet, said he, all these reflect the wonders of the Creation as much as the trees and flowers of the countryside. We are, he added, all apt to look on scientific progress as purely utilitarian; we forget that we merely harness the mechanisms of the Creation. We create nothing. Lady Parsons joined in the conversation. It was, I think, a most unusual topic even to her. On me the conversation left a lasting impression. Parsons was not only a gentleman, a great scholar and a famous engineer, he was also a man who visualized God's minute mechanisms and marvelled at the Creation."

NEWS and VIEWS

Mathematics at St. Andrews: Prof. H. W. Turnbull, F.R.S.

THE retirement of Prof. H. W. Turnbull from the regius professorship of mathematics in the United College, University of St. Andrews, marks the end of twenty-nine years of distinguished service to mathematics in Scotland. Between 1909, when he was Smith's Prizeman at Cambridge, and 1921, he had a rather varied career, including teaching posts in the University of Liverpool, in St. Stephen's College, Hong Kong, at Repton and Shrewsbury, and he was one of H.M. Inspectors of Schools during 1919–21. In St. Andrews he returned to his first interests, fostered as they had been at Cambridge by Alfred Young and J. H. Grace, and he devoted himself to inculcating a love of invariant theory, algebraic geometry and algebra itself in a generation of students. He found time also for writing many papers and some text-books, and was ever ready to help and collaborate with younger men. The Royal Society of Edinburgh recognized his work by awarding him the Keith Medal and the Gunning Victoria Jubilee Prize. In the history of mathematics, he made important discoveries among the letters and correspondence of James Gregory, the results being embodied in the James Gregory Memorial Volume.

It is a pleasure to refer to the multitude of his friends. Those who have met him at mathematical conferences will easily recall his genial presence, his versatility in music (shared by his wife), chess, cricket, golf and mountaineering. He retires to the Lake District to pursue historical research bearing on the work and correspondence of Newton; and there he may continue to feel himself accompanied by the general good wishes of mathematicians.

Prof. E. T. Copson

PROF. EDWARD T. COPSON, who succeeds Prof. Turnbull, was educated at St. John's College, Oxford, whence he proceeded in 1922 after graduation to a post as lecturer in the Mathematics Department of the University of Edinburgh. With the exception of a short period when he was at the Royal Naval College, Greenwich, he has worked continuously in Scotland, first at Edinburgh, later as head of the Applied Mathematics Section in the United College at St. Andrews and later still as professor of mathematics in University College, Dundee. Prof. Copson is interested in pure mathematics and particularly in those branches of analysis and partial differential equations which have direct bearing upon mathematical physics. He has written and published many original papers on these subjects, and his text-book upon the complex variable (Oxford University Press) has a wide circulation both in Great Britain and in the United States. In collaboration with Prof. B. Bevan Baker, he wrote a distinguished memoir on Huygens's Principle that also has received wide recognition. It deals with the geometrical structure and generation of waves from a mathematical point of view that has considerable physical applications. During the Second World War Prof. Copson made useful contributions to technical problems raised by the Admiralty, in which he exhibited the practical application of higher mathematical analysis. He has a high reputation as an attractive lecturer and teacher.

'Airmet' Petition

THE launching of a petition for the restoration of the 'Airmet' weather broadcasts of the B.B.C. was announced on October 5. The petition is being organised by the magazine *Weather* on behalf of the Royal Meteorological Society, which is acting as a focus for all those bodies which found the 'Airmet' service of value. 'Airmet' was started in 1932 by the Aviation Division of the Automobile Association, primarily for the use of aircraft owner-pilots, and was taken over by the Meteorological Office three years later. Apart from the break for security reasons during the War, the service continued until March 1950, when the Copenhagen Broadcasting Plan was introduced, under which no provision had been made for 'Airmet'. Speakers from the aviation, agricultural, educational and sporting worlds at a meeting on October 5 made it clear that 'Airmet' had latterly served a very wide public in a way which could not possibly be met by the normal weather forecasts issued by the B.B.C. The chief features of 'Airmet' were the up-to-the-minute nature of the weather reports, the greater details given in the forecasts, the continuous availability of the service throughout daylight hours and the intimate relationship it provided between the forecaster and the public. Such a service can only be provided by radio, and a telecommunications expert pointed out that the petition might fail unless constructive suggestions were made for overcoming the wave-length difficulties. The most obvious solution seemed to be to use one of the Third Programme wave-lengths until 6 p.m., and the question probably resolved itself into which was of greater importance—the provision of an extra channel for the B.B.C. Overseas Service (such appears to be the present use of the Third Programme wave-length prior to 6 p.m.) or the restoration of 'Airmet'. People signing the petition are asked to state their main reason for requiring 'Airmet'; an analysis of the information thus made available might well prove to be of considerable economic and sociological interest and suggest lines along which a renewed service could be enhanced in value. Copies of the petition may be obtained from *Weather* ('Airmet' Petition), 49 Cromwell Road, London, S.W.7.

The Upper Atmosphere

A RECENT publication, "La haute atmosphère", by R. A. Boutet (Publication No. 38; pp. 121; Paris: Office National d'Études et de Recherches aéronautiques, 1950), reviews the knowledge of the upper atmosphere and the means whereby this knowledge has been obtained and may be increased. Reproduced photographically from typescript, it contains sections devoted to the atmospheric composition, thermodynamics (temperature and pressure), optical sounding by observation of natural scattered light, sounding by a searchlight beam, the intensity and spectrum of the light of the night sky, acoustic sounding, biological relations (effect of altitude on human physiology, influence of ultra-violet light, animal and vegetable life, and bird migrations), the winds, cosmic radiation, meteors and their trails, relationship of the upper atmosphere with perturbations of the lower atmosphere and of the ionosphere, with vulcanism and with solar changes, and the atmospheric tides. The volume contains much that repays reading; but the scope is vast, and the author, clearly not a specialist in all the fields covered in the volume, occasionally errs. The book ends with a five-page bibliography, marred by some wrong attributions of authorship and by many instances of quotation of author and title only, without indication of place and date of publication.

Museum of Applied Science of Victoria

THE report for 1948–49 of the Museum of Applied Science of Victoria (pp. 36. Melbourne: National Museums of Victoria, 1950) contains an unusual item of information in that it records some astronomical telescope demonstrations. These are given in conjunction with the Astronomical Society of Victoria to selected parties on three nights in each month. It is stated that the demonstrations are well attended and that there is a waiting list of applications. An 8-inch telescope is used, and the demonstrator is granted an honorarium for his services. The same report also states that a new Section of Preventive Medicine has been established in the Museum. The programme of exhibits includes nutrition, avoidance of infection, occupational hazards, fallacious beliefs, etc. The subject is approached from the health and safety angle rather than the pathological, thereby minimizing the risk of creating a state of morbid anxiety in susceptible individuals.

New Type of Automatic Aperiodic Balance

THE May issue of the "Nivoc Supplement", published by W. and J. George and Becker, Ltd., is a special balance issue and reviews the wide range of balances, including the new 'Nivoc' automatic aperiodic balance and weights, produced by this well-known firm of laboratory furnishers and manufacturers of scientific equipment. Incorporated in the automatic aperiodic balance is an entirely new principle of weight selection, in addition to the attractive and useful features of the older 'Nivoc' aperiodic balance. Weight error is reduced to a minimum, and the time of each weight determination

is only a few seconds. The normal capacity of the balance is 200 gm. and the sensitivity 0·1 mgm.

International Congress on Analytical Chemistry, 1952

In connexion with the International Congress on Analytical Chemistry, to be held in Great Britain in 1952 (see *Nature*, February 11, p. 223), it has been decided that the meetings shall be held in Oxford, commencing on September 4. Accommodation will normally be provided in the Colleges; but some hotel accommodation will also be available. The technical sessions will take place in one of the main University buildings. The arrangements for the Congress are in the hands of a general committee under Sir Robert Robinson, representing a wide variety of interests. The scope of the proceedings is being dealt with by an executive committee, under the chairmanship of the president of the Society of Public Analysts and Other Analytical Chemists, Mr. G. Taylor, and further details of this and other matters will be published in due course. It is expected that a meeting of the Board of Section 5 (analytical chemistry) of the International Union of Pure and Applied Chemistry will be held in Oxford during the same week. Sir Ian Heilbron is honorary president, and Prof. C. J. van Nieuwenburg president of this Section of the International Union. Sir Wallace Akers is honorary treasurer of the Congress, and the honorary secretary is Mr. R. C. Chirnside, of the Research Laboratories, General Electric Co., Ltd., Wembley, Middlesex.

University of Birmingham

The following appointments in the University of Birmingham have recently been announced. Dr. C. S. Ball, lecturer in industrial metallurgy; K. Aterman, lecturer in biophysics in the Department of Anatomy; G. E. R. Burroughs and Miss M. L. Kellmer, lecturers in education; H. W. Paxton, research fellow in metallurgy; G. F. Eveson, research fellow in coal treatment in the Department of Mining; M. G. Cockcroft, research fellow in industrial metallurgy. The following resignations have been announced: Dr. H. B. Whittington, reader in palæontology, on appointment as associate professor in the Museum of Comparative Zoology, Harvard University; Dr. H. Scarborough, reader in medicine, on appointment as professor of medicine and director of the Medical Unit at the Welsh National School of Medicine, Cardiff.

Announcements

The Reith Lectures for 1950 of the B.B.C. are to be given by Prof. J. Z. Young, professor of anatomy in University College, London, on "Doubt and Certainty in Science—a Biologist's Reflexions on the Human Brain". The eight lectures will be broadcast on Sunday evenings in the Home Service from October 29 until December 10; this is a fortnight earlier than was originally announced.

The Radford Mather Lecture of the British Association will be delivered by Sir Lawrence Bragg on October 25, at 5.15 p.m., in the lecture room of the Royal Institution, Albemarle Street, London, W.1; Sir Lawrence will speak on "Science and the Adventure of Living". Admission is by ticket, which may be obtained by members of the Association for themselves and their friends from the British Association, Burlington House, Piccadilly, London, W.1.

Lord Haden Guest has been elected president of the Association of Scientific Workers in succession to Lord Boyd-Orr, who has resigned on account of the increased pressure of his other commitments. Lord Haden Guest, who was member of Parliament for North Islington until his elevation to the peerage this year, is chairman of the Medical Priorities Committee of the Ministry of Health and secretary of the Leverhulme Research Fellowship Committee.

Dr. B. F. J. Schonland has recently retired from the post of president of the South African Council for Scientific and Industrial Research and is resuming the directorship of the Bernard Price Institute of Geophysical Research, University of the Witwatersrand. Dr. P. J. du Toit has been appointed to succeed Dr. Schonland, and Dr. S. Meiring Naude, the present director of the South African National Physical Laboratory, will take on the duties of vice-president of the Council.

Ramsay Memorial fellowships for 1950–51 have been awarded to the following for chemical research at the universities stated: E. Gelles, University College, London; Dr. R. W. A. Attree (Canadian), Bristol; and Miss M. J. Molera (Spanish), Oxford. The following fellowships have been renewed for 1950–51: Dr. P. Gray, Cambridge; H. Mendel (Netherlands), Oxford; and Dr. K. Leu (Swiss) and Dr. Margaret Whalley, Imperial College of Science and Technology, London.

The Meldola Medal is the gift of the Society of Maccabæans and is normally awarded annually. The next award will be made early in 1951 to the chemist who, being a British subject and less than thirty years of age on December 31, 1950, shows the most promise, as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

A course of six lectures on "Radiochemical Methods of Analysis" has been organised by the Department of Chemistry, Sir John Cass College, Jewry Street, London, E.C.3, and will be held on Tuesdays at 6 p.m., beginning on November 7. The course will be given by Dr. A. G. Maddock (Radiochemical Laboratory, University of Cambridge), and Dr. J. F. Duncan (Atomic Energy Research Establishment, Harwell). It will form an introduction to further lectures on radiochemical analysis, and these will later be followed by a practical course for a limited number of students. The fee for the course of six lectures is 15*s*., and application for enrolment forms should be made to the principal of the College.

A conference of the International Institute of Refrigeration, the first since before the War, will be held in London during August 29–September 7, 1951. Most of the special commissions of the conference will be dealing with technological matters; but low-temperature physics will be considered at a joint meeting of the Scientific Commission of the International Institute of Refrigeration with the new Commission for Very Low Temperatures of Unesco. Further information can be obtained from Dr. G. G. Haselden, honorary secretary of the Low Temperature Group of the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

DEVELOPMENT OF MAN'S USE OF POWER

THE theme for the Birmingham meeting of the British Association being "Man's Use of Energy", Section H (Archæology and Anthropology) accordingly devoted the afternoon of September 4 to consideration of this topic.

The proceedings were opened by Mr. B. A. L. Cranstone (British Museum) with a paper on "Primitive Man's Use of Power", in which he discussed the factors governing the harnessing of power by modern and ancient peoples possessing stone-age cultures. The Palæolithic stage, in which the dominant material for tools is flaked stone, is normally correlated with a hunting and food-collecting economy; the human group is small and is usually compelled to lead a wandering life. The only portable source of power is the muscle power of the individual, which is applied mainly to missile weapons: the bow, the spear-thrower, the blowgun. Stones may be used for grinding seeds, and the digging stick, which applies the principle of the lever, is found; but requirements in the fields of clothing or containers can be met by the use of skins or other natural objects.

In the Neolithic stage, the use of ground stone or shell tools is correlated with a settled life based on agriculture and stock-breeding. Many new opportunities for using power are presented, but for a variety of reasons relatively few are exploited. Machinery can now be static, and wind- and water-power are therefore available, together with a new source in the domesticated animal. Many new requirements of containers and buildings are realized, and the relative scarcity of skins for clothing (except among pastoral peoples) leads to the invention of the loom. But water- and wind-power are not harnessed, except in the case of the sailing boat, and milling or water-raising machinery is not developed.

The reason cannot lie in lack of manual skill; the Polynesians, for example, made boats with which they populated the Pacific. Mr. Cranstone suggested that one reason lay in the lack of metal tools, pointing out that primitive machinery must usually be made of wood, and that wooden working parts wear out quickly. The labour of constantly replacing them with stone tools would neutralize the economic value of the machine. Machinery, including the wheel, did not appear in the ancient civilizations of the Near East until copper tools were available; and in ancient Mexico, though the wheel was known, it was only used on toys, suggesting that its application to transport may not have been economically profitable.

Prof. H. F. Humphreys (University of Birmingham) suggested that Mr. Cranstone might have underestimated other factors, such as the innate conservatism of primitive peoples. It was also suggested that a hard wood such as lignum vitæ makes a durable bearing, and that the hard work caused by friction may be as important as the wear on moving parts.

Mr. A. Stowers (Science Museum, London) contributed a paper on "Some Primitive Applications of Power to Pumping and Blowing", which was read by Mr. Adrian Digby and was illustrated with lantern slides. Mr. Stowers pointed out that means of pumping water and blowing air were two of the fundamental requirements of civilization, because the earliest civilizations were based on irrigation agriculture; in some countries (for example, Holland) land could only be reclaimed by pumping and drainage; with the development of mining, draining and artificial ventilation became essential; and an artificial blast was necessary in the smelting of ores.

The first power resource was man-power. Later, domestic animals became available, and their tractive effort had usually to be converted to rotary motion by means of gearing and rotating shafts. Water-wheels provided greater power; but, like wind-power, water-power was unreliable compared with animal power.

In the Primitive, Classical and Middle Ages, most of the steps in man's increasing control of energy were probably due to the requirements of pumping machinery; for this, compared with other machines, required more power which had to be transmitted over increasing distances. Up to the end of the fifteenth century, the maximum power from a rotative prime mover was a few horse-power transmitted up to about 200 ft. by ropes; but by the end of the seventeenth century single water-wheels of about 20 h.p. and transmission up to a quarter of a mile by reciprocating rods were achieved. Mr. Stowers concluded by explaining that smelting and other processes in copper- and iron-working depended on the use of some form of bellows to increase the heat of the furnace, and showed examples of hand- and foot-operated bellows from ancient and modern peoples.

Mr. Digby emphasized that the machine is a specialized device (unlike generalized tools which have a number of uses) and will only be developed in response to a sustained and clear need; the primitive machine develops a low horse-power and requires a large amount of maintenance. He also suggested that the use made by primitive man of the time saved by a new machine should be investigated. Sir Harold Hartley (president of the British Association), referring to his experience in South Africa, said that the value of water raised by an improved method depends on the skill of the native user, who among peoples not accustomed to irrigation may lack the necessary technical skills, such as a sense of levels.

Lastly, Mr. G. E. Fussell read a paper on "Agricultural Change and the English Village". He showed that, in the Middle Ages, though 90 per cent of the population was engaged in farming, agricultural technique was not sufficiently advanced to provide an assured food supply for all. This position remained practically unchanged until the middle of the eighteenth century, though the structure of society and the ownership of land had changed radically; farming practice had improved, but not enough to compensate for the increase of population. New crops, improved rotations, selective stock breeding, and the gradual introduction of implements such as the seed drill and threshing machine increased production, but by 1850 the population was still outstripping the food supply. The medieval villein could not produce an adequate food supply; the villager of 1850 could not obtain a wage high enough to allow him to buy it.

After 1850, improvements, some introduced long before, caused an accelerated increase in yields. The changes included the introduction of new fertilizers, government loans to assist drainage schemes, the

adoption of the steam engine as the power unit and many new machines for use in field and barn. But the villager shared relatively little in this improvement. From 1700 until about 1900, when more varied fare became available, the main changes in rural diet were a decrease in the consumption of milk and a heavy increase in that of potatoes.

The two World Wars, with the consequent emphasis on cereal production, the increased rate of technical development and particularly the substitution of tractor- for animal-power have completely changed the farm worker's status. Rural housing still compares unfavourably with that of the towns; but in wages and clothing the farm worker has achieved equality, and his food supply is now superior to that of the urban population.

Mr. Fussell finally suggested that the farmer and farm-worker can only achieve equality with the rest of the community when the emphasis is on cereal and potato production, and the whole population is reduced to a regulated diet.

Dr. R. N. Salaman (president of Section H) said that the modern use of the tractor made deep ploughing possible, and on heavy land this improved drainage and greatly increased yields. The farm labourer is becoming a mechanic; the farmer himself must supply the agricultural knowledge, and is far better equipped in this sense than his ancestors.

B. A. L. Cranstone

LIGHTING OF MUSEUMS AND GALLERIES

A DISCUSSION on museum and gallery lighting took place on September 5 during the Birmingham meeting of the British Association under the chairmanship of the president of Section A (Physics and Mathematics), Prof. E. H. Neville.

Mr. W. E. Rawson-Bottom (Ministry of Works) referred in his paper to the demand for better lighting which has come about generally, and to the enhanced public interest in museums. Standardized methods have not been found possible: each case should be individually treated. But whatever the system, attention should be directed naturally to the exhibits, and not to a number of bare lamps or fittings which are themselves objects of high brightness. The aim should be to produce an effect without an apparent cause. Lack of interest sometimes arises from an unduly even level of distribution of illumination over a larger area, although on occasions this is desirable.

Fluorescent lamps are now becoming increasingly available in a number of forms. The 'Daylight' type, functioning at a colour temperature of around 4,500° K., has been found the most effective for general use. 'Warm white' lamps render colour poorly, and moreover they mix badly with natural daylight. Filament lamps still find valuable application in spot-lighting and when brilliance and sparkle are needed.

In order to reduce unpleasant glare, screening of these fluorescent lamps by metal louvres has proved its worth. Showcase lighting is best arranged internally; careful choice of background material and colour will go far to reduce the annoyance of reflexion from the glazing, and keeping it below the nuisance-level.

Experiments have been conducted to do away with the frosted glass top-panels sometimes provided for show-cases, and to replace them by dark-coloured louvres behind which is an efficient reflector. It is assumed, of course, that shelving is of glass, not wood. The observer is, in general, little conscious of the illumination.

If it is intended to use fluorescent lighting in dioramas, the artist responsible will naturally need to work with light of this character, otherwise his distance and perspective will suffer serious distortion.

A number of slides, illustrative of past and present practice in museum lighting, were shown by Mr. Rawson-Bottom, from which it was clear what advances have been made in all branches of technique for the æsthetic and truthful illumination of exhibits.

Mr. F. I. G. Rawlins (National Gallery, London), in his paper on the lighting of picture galleries, emphasized the close connexion between gallery architecture and systems of illumination. Dealing with buildings not specifically designed for artificial illumination raises considerable difficulties, which of course became less severe when galleries were treated with modern lighting fully in mind. We have now reached the stage when experiment is likely to yield worth-while results. Between the two World Wars, high-wattage lamps were the rule; they were by no means unsuccessful up to a point, partly because many buildings possess marked vertical lines with which lantern fittings could be made to harmonize reasonably well. The intensity, however, was poor, and the colour-correction inadequate. Spot-lighting at that period was not very successful: it produced a depressing gloom above and around which was generally regarded as forbidding.

The arrival of the fluorescent tube marked a great advance. Its colour properties at once showed improvement, and they are likely to reach still better standards. With good positioning for height and distance, some 25 foot-candles can now be obtained at a height of 5 ft. above the floor, compared with about 4 foot-candles fifteen years ago, using 1,500-watt gas-filled lamps.

For pictures, backgrounds are of prime importance, especially when looking at relatively small paintings. Backgrounds should be selected from materials having a low coefficient of reflexion, if distraction is to be avoided. Mr. J. Bickerdike has made tests of a preliminary character, which show that pictures possess reflectivities of around 10, 20, 35 per cent, of which 20 per cent is far the most common. This, then, gives a hint of how backgrounds should be chosen, and it is remarkable how pleasing they are, when of this order of reflectivity. In conclusion, Mr. Rawlins suggested that some variety of light and shade is to be welcomed, in preference to an overall uniformity of brightness-level throughout a picture gallery. A number of slides demonstrated the effect of intensity distribution and backgrounds at the National Gallery, London.

In opening the general discussion, the chairman asked what steps are being taken to eliminate the irritating reflexions arising from the glazing of pictures. He also inquired whether anything is being done to encourage students to study specifically the subject of museum and gallery lighting. The first question raises many difficulties: a partial solution is to avoid windows opposite, and to provide dark walls on that side; but this does not get rid of the reflexion from the spectator's own person. There are, of course, a number of palliatives; but the basic course is to remove the glass altogether, which is

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only possible, in British cities, if an air-conditioning and air-washing plant is in operation; and the cost of that is very great.

At present, no deliberate effort is made to attract recruits to the special study of museum and gallery lighting. It is, however, one of the subjects which the recently incorporated International Institute for the Conservation of Museum Objects hopes to include in its syllabus of training.

In connexion with colour correction problems, Mr. Rawson-Bottom explained that, in general, the standard daylight fluorescent lamp is satisfactory for most situations. In special cases where colour rendering is of particular importance, the 'colour-matching' fluorescent lamp is used, but he emphasized the necessity of providing sufficient intensity when using this type of lamp.

SOCIO-PSYCHOLOGICAL FACTORS IN PRODUCTIVITY

A SYMPOSIUM on "Socio-psychological Factors in Productivity", arranged by Sections F (Economics) and J (Psychology) of the British Association, was held at Birmingham on September 4.

The problem jointly selected by the four speakers was the question of the relative strength of the pecuniary and non-pecuniary incentives to work. Each of them discussed the *general* complexity of the problem and emphasized the multitude and variety of the motivational factors involved. While on this point there was general agreement, each paper presented its own contribution derived from research on *specific* aspects of the problem.

Prof. P. Sargant Florence (University of Birmingham) opened the discussion with a brief survey of the variety of incentives. It is essential to distinguish between incentives or 'attractives' to move from one job to another, and incentives to perform a given job. The former kind refers to labour mobility, and economists have put forward a frame of reference which comprises, besides the wage-level, such factors as bodily and mental fatigue and social environment. As to productivity on a given job, it is of the greatest importance to measure the relative strength of pecuniary and non-pecuniary incentives. Psychologists, though often paying lip-service to the incentive power of the wage and the method of paying wages, in practice neglect the subject. A balanced inquiry should not only weigh factors in isolation but should also see whether economic factors *plus* certain socio-psychological factors (for example, changes in supervision, or changes in goods and services the worker can buy) might not increase productivity more than the sum of each factor taken separately. Prof. Florence recalled that during the First World War the Health of Munition Workers Committee in Britain and the U.S. Public Health Service (Bull. 106, published in 1920) showed statistics of output, spoilt work and accidents hour by hour throughout the working day which fell into standard patterns of 'work curves'. These curves were fairly generally interpreted as manifestations of practice effect, fatigue and boredom. For one type of curve, that of accidents, two patterns were obtained. The curve of night-shift accidents fell at first hour by hour, and interpreting this phenomenon, Dr. H. M. Vernon stressed the importance of disturbance due to excitement previous to coming to work; the day-shift accident curve, however, rose throughout the two spells, and this was explained by Prof. Florence chiefly as a symptom of fatigue. The controversy began in 1923–24, but the relative importance of fatigue and excitement has never been resolved. The facts seem assured and have since been confirmed with regard to the day-shift accident curve. What is wanted is an interpretation; socio-psychologists, however, have so far not been forthcoming with it, although this would clearly have been within their sphere.

Among the more specific points raised by the three other speakers were the following: Mr. R. Marriott (Medical Research Council) discussed the effect of group-size on productivity, referring to an investigation made two years ago[1]. Indirect measures of output based on the payment systems could be obtained for two factories. In factory *A* there were 4,500 workers distributed among 153 groups of different size and they were studied in five consecutive quarterly periods. In factory *B* there were 1,000 workers with an average of 90 groups. In this study, groups of fewer than ten men, 10–19, 20–29 and so on, and more than 50 men were combined. Mr. Marriott demonstrated with a diagram that in both factories productivity decreased as the size of the groups increased up to the 49-level. The output averages for the smallest groups were 5–17 per cent higher than the averages for the groups containing between 40 and 49 men. The correlations were low (between −0·2 and −0·5 per cent), but this inverse relationship was consistent and statistically significant for each period in both factories. It is difficult to account for the rise in output in the groups with 50 and more men. One explanation is the effect of power-driven conveyors, which were used mainly in the larger groups. Evidence from this and other investigations[2] suggests that the inverse relationship between group-size and productivity is the result of greater cohesion in small teams because men know each other better, can see each other at work and consequently are less suspicious and require less supervision. One important point to note is that group-size seems to be independent of other factors, for there was much evidence that productivity was higher in factory *A*.

Mr. R. G. Stansfield directed attention to a factor the importance of which is usually overlooked, namely, the 'level of expectation' productivity, that is, the customs which settle what is taken naturally as the proper output. In productivity just as in other matters of behaviour, what a person does is, in the short run, determined by what he is accustomed to do. By analogy with physical science, an incentive can be regarded as a force applied to a person to make him work harder; as a physical body can be subjected to a force, so a person has his inertia in work and in social behaviour, and what a person is 'accustomed' to do corresponds to the 'momentum' of the body. Paraphrasing Newton, Mr. Stansfield suggested as the First Law of Socio-Psychological Motion: "Every person continues in his state of rest, or of uniform work in a straight line, unless he is compelled by impressed incentives to change his state". The expectation of the persons immediately around is one of the most powerful incentives, and the 'climate of opinion' which is the aggregate of these expectations shows an inertia adding to the inertia of the person subject to the 'climate'. Quoting from his own war-time observations of the performance of groups of persons plotting aircraft movements, Mr. Stansfield said that evidence showed the average group-to-group

variation in performance to be greater than the variation between individuals within a group—the range being of the order of 2 : 1—which suggested that 'social' effects had a greater impact on productivity than individual ability. In fact, the 2 : 1 ratio corresponded to the difference in the level of expectation between the groups observed. Comparative productivity studies between firms in the boot and shoe, building and cotton industries, undertaken since, confirmed the existence of a ratio of this order.

Dr. W. Baldamus (University of Birmingham) pointed out that variations in productivity are often explained by sociopsychological factors (such as supervision), whereas in fact they are due to differences in type of work. For the past thirty years, both economists and executives have firmly believed that variations in annual labour turnover-rates (number of employees leaving, as a percentage of number employed) between different companies, factories and departments are due chiefly to differences in supervision, leadership and efficiency of personnel management generally. Referring to an inquiry on labour turnover in six Midland companies (1947–49), Dr. Baldamus reported that he discovered this traditional belief to be a fallacy. He found that differences in turnover-rates between different factories of the same company are extraordinarily large, ranging from about 10 per cent to 80 per cent. The true reason revealed itself the moment the data were analysed according to type of work instead of factory units. It appeared then that the lower rates were characteristic of highly skilled jobs (tool-makers, floor moulders, etc.), and the highest rates represented general labourers, crane drivers, enamellers, etc. In all companies the turnover-level of heavy labourers was more than 80 per cent, and in one case as high as 730 per cent. It follows that factories differ in turnover-rates primarily not because of differences in personnel management, but because the proportion of different types of labour, particularly of unskilled labour, varies. Turnover tends to be higher the shorter the work-cycle and the shorter the period of training. Dr. Baldamus believes that motivational factors inherent in the type of work, such as tedium and nervous strain, but also intrinsic satisfactions, are decisive in labour turnover; their importance, however, for increasing labour stability and thus productivity has so far been entirely missed.

W. BALDAMUS

[1] Cf. *Occup. Psych.* **23**, No. 1, 47 (1948).
[2] For example, Mukerji, N. F., *Brit. J. Psych.*, **30**, 356 (1940).

EFFECT OF MOTOR PATROLS ON ACCIDENTS

By GRACE O. JEFFCOATE

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THE Road Research Laboratory of the Department of Scientific and Industrial Research is investigating the effects of police activity on road accidents, and, as a part of this work, an investigation has been made into the effects of the experimental motor-patrol scheme originated by the Home Office in conjunction with the Ministry of Transport in 1937. The object of this scheme was to find the effect of an increase of motor-patrol police on road accidents and road behaviour. The main idea was co-operation and education rather than prosecution. This scheme provided mainly for the augmentation of the existing motor patrols by specially trained men in seven police districts of England, and was in operation in most of these districts from April 1, 1938, to September 3, 1939. The men were trained to set an example by their own driving, to give advice and warnings on the spot, and to teach road safety to all classes of road users. They were trained at various centres, the course being based on a scheme by Lord Cottenham.

The only comprehensive figures published on the effect of the scheme are those given in the report by the House of Lords Select Committee on the Prevention of Road Accidents[1]. This merely states that, in the first six months of the experiment, the road casualties in the participating police districts decreased by the following percentages, as compared with the corresponding six months of the previous year: Lancashire 46, Salford 20, Cheshire 11, Manchester 8, Essex 6, Liverpool 6, and Metropolitan (London) 5 per cent.

The decrease for the whole of England and Wales for this period was 5 per cent, so that some of the above changes do not appear to be outstanding. However, as this 5 per cent includes the large decreases in those districts in which the experiment was tried, a better comparison is with the remainder of the country. No reliable data seem to exist which would make it possible to calculate this; but approx-

Table 1. EFFECT OF SCHEME ON CASUALTIES*

Forces not operating the scheme (England only)		
Change (per cent)	No. of county police districts	No. of groups of town and city districts
Increase in number of casualties: 20 and over	1	1
15–20	2	1
10–15	4	4
5–10	7	7
0–5	12	12
Decrease in number of casualties: 0–5	9	8
5–10	5	4
10–15	1	—
15 and over	—	—
Total number of districts or groups	41	37
Average of percentage changes	3·0 increase	3·1 increase
Average change (per cent)	1·7 increase	2·8 increase

(*a*)

Forces operating the scheme			
Districts	Casualties 1937	Casualties 1938	Decrease (per cent)
Liverpool	4,314	4,371	—1·3
Manchester	4,532	4,425	2·4
Salford	508	457	10·0
Lancashire	7,303	4,611	36·9
Essex	4,779	4,473	6·4
Cheshire	3,189	3,120	2·2
Metropolitan	57,256	56,715	1·0
Total	81,881	78,172	4·5
Average of percentage changes			8·2 decrease
Average of percentage changes excluding Lancashire			3·3 decrease

(*b*)

* For consistency all figures are those given in Ministry of Transport publications[2].

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Table 2. EFFECT ON FATALITIES

Type of force	Number of fatalities					
	Forces operating scheme			Forces not operating scheme		
	1937	1938	Change (per cent) { increase + / decrease − }	1937	1938	Change (per cent) { increase + / decrease − }
County	535	503	− 6·0	2,652	2,767	+ 4·3
Metropolitan, city or borough	1,239	1,152	− 7·0	1,279	1,296	+ 1·3
Total	1,774	1,655	− 6·7	3,931	4,063	+ 3·4

imate calculation indicates that it was probably about 2 per cent.

However, although six-monthly figures of road-accident casualties are not available for the separate police districts, annual figures have been published by the Ministry of Transport, and, to obtain a better comparison and to verify that the difference was not a chance effect, figures for 1937 and 1938 have been compared and the results are given in Tables 1 (*a*) and (*b*) (Wales being omitted to obtain a more homogeneous group). The percentage change from 1937 to 1938 in the number of casualties has been calculated for each police district, except that some of the town and city districts are grouped in order to provide larger and more reliable figures. Table 1 (*a*) shows the percentage changes in the casualty-rate of those districts not operating the scheme. Some districts showed improvements, but the overall effect was an increase in the number of casualties, and the average of the changes was a 3 per cent increase. Table 1 (*b*) similarly shows the variation in the percentage change of casualties in the districts operating the scheme, ranging from an increase of 1 per cent to a decrease of 37 per cent, with an average decrease of 8·2 per cent. The difference between this and the average increase of 3 per cent for the forces not operating the scheme is statistically significant when compared with the variations within each group mentioned above, and this remains true even if Lancashire, with its large improvement, is omitted. These percentage changes are more favourable than appears at first glance because the scheme only began in April 1938. No comparison can be made between the quantitative effects in the seven police districts, since there was considerable variation between the strengths of the patrols and of their spheres of operation.

Of the casualties in this same period, the fatalities are not sufficiently numerous to be analysed in the same way; but Table 2 summarizes the results.

The number of fatalities again shows a significant reduction of 6·7 per cent in the districts operating the scheme when compared with the increase of 3·4 per cent in the remaining districts. The corresponding figures for fatal accidents, as distinct from deaths as a result of these accidents, show a decrease of 6·8 per cent for the districts co-operating and an increase of 3·2 per cent for the remaining districts. These results suggest that the experimental motor-patrol scheme was effective in reducing road accidents, and that the improvement in the accident-rate was probably about 10 per cent.

It has already been stated that the basic idea of the scheme was co-operation and education rather than prosecution. In the seven police districts concerned[2], the number of prosecutions fell from 162,701 to 142,801, a decrease of 12 per cent. Of these prosecutions the majority were in the Metropolitan area of London, the fall being from 117,332 to 101,318, that is, 14 per cent. Only two areas showed a rise (Essex 2 per cent, and Cheshire 14 per cent); the others all showed falls of 15–21 per cent. For the rest of England, where the patrol scheme was not in operation, the prosecutions increased from 259,289 to 272,323, that is, 5 per cent. This suggests that not only did the scheme have a good effect on the accident position, but also that it tended to reduce the number of prosecutions.

[1] House of Lords. Report by the Select Committee on the Prevention of Road Accidents (Session 1938–39), together with the proceedings of the Committee, minutes of evidence and index. Pp. 101. (London: H.M. Stationery Office, 1939.)

[2] (*a*) Ministry of Transport. Road Accidents involving Personal Injury, Great Britain, 1937. (*b*) Road Accidents involving Personal Injury, Great Britain, 1938. (London: H.M. Stationery Office, 1938–39.)

[3] (*a*) Home Office. Return of Offences relating to Motor Vehicles (during the year ended 31st December, 1937). (*b*) Return of Offences relating to Motor Vehicles (during the year ended 31st December, 1938). (London: H.M. Stationery Office, 1938–39.)

CHEMICAL ACTION OF IONIZING RADIATIONS ON NUCLEIC ACIDS IN AQUEOUS SYSTEMS

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WE have previously reported[1] some preliminary observations on the effect of X-rays on aqueous solutions of nucleic acids, and showed that some of the chemical changes involved are very similar to those produced by hydrogen peroxide in the presence of ferrous salts. This we interpreted as a degradation of the polynucleotide by attack of the free radicals (particularly the OH radical) which are initially formed according to the net process[2]:

$$H_2O \longrightarrow\!\!\!\!\sim\!\!\!\!\sim\!\!\!\!\rightarrow H + OH \qquad (1)$$

by the action of the radiation on the water itself. Limperos and Moscher[3], and Butler and Smith[4], have recently confirmed this view by a study of the viscosity changes of sodium deoxyribonucleate solutions as induced by X-irradiation and treatment with hydrogen peroxide – ferrous salt reagent.

In order to detect and particularly to isolate any products formed in the irradiated solutions, we had previously employed fairly high doses ($\sim 10^6$ r.). We actually observed the formation of ammonia, free inorganic phosphate, small amounts of free purine bases and an increase in the Van Slyke amino-nitrogen values. In agreement with this, the production of ammonia and a ring fission have been

observed in the study of the action of X-rays on aqueous solutions of the free purines, adenine, guanine, hypoxanthine and xanthine. This fission is also indicated, for example, by the liberation of carbon dioxide from all the four purine bases. The pyrimidines are also subject to chemical change; evidence that the pyrimidine ring system may be opened by the action of the radicals arises from some preliminary experiments on uracil, where small amounts of ammonia could be detected after X-irradiation. Again, employing as substrate a simple mononucleotide, adenylic acid, experiments have shown that the production here of free adenine and of free inorganic phosphate illustrates the susceptibility to fission of both the glycosidic and phosphoester linkages in a polynucleotide structure.

These results, in general, may be of significance in view of the recent findings of Limperos and Moscher[3], who have shown that there is a splitting off of the purine bases in the thymus deoxyribonucleic acid of irradiated rats.

We have now carried out experiments with much smaller doses of radiation. Previous investigations[4] on sodium thymonucleate solutions, using smaller doses of the order of 20,000–60,000 r., have been essentially concerned with the decrease in viscosity as a consequence of irradiation; no chemical changes have been reported. We have investigated the nature of the chemical changes as produced by similar low doses on dilute aqueous solutions of the nucleic acids. Of the products which we have already found when employing higher doses, we have observed again the formation of ammonia and of inorganic phosphate as a result of the chemical action of the ionizing radiation. Experiments have been performed using 0·05 per cent aqueous solutions of sodium ribonucleate of yeast (British Drug Houses, Ltd.) and the sodium salt of thymus deoxyribonucleic acid. A highly polymerized sample of the latter was supplied by Prof. R. Signer (Berne).

Using the methods described in our previous communication[1], we have been able to detect and estimate small amounts of *ammonia* and of *inorganic phosphate*, which are both formed when the solutions of nucleate are irradiated with doses as low as 30,000 r.

Table 1 gives some representative values for the yields of ammonia and of inorganic phosphate from irradiated solutions of yeast ribonucleic acid and thymus deoxyribonucleic acid. Figures for three selected doses are given.

It can be seen that the yield of ammonia is only slightly higher in the case of ribonucleic acid, but that relatively more inorganic phosphate is formed. In general, we have observed that the dose-yield curve is linear in the case of ammonia formation, but rises slightly in the case of the phosphate yields.

In addition to these experiments in air, irradiations have also been performed in vacuum and in hydrogen, a technique[4] which may give valuable

Table 1. AQUEOUS SOLUTIONS (0·05 PER CENT) IRRADIATED WITH X-RAYS (200 kV.) IN THE PRESENCE OF AIR

Dose in r.-units	Yeast ribonucleic acid		Thymus deoxyribonucleic acid (Signer)	
	Ammonia moles × 10^6 per 100 ml.	Inorganic phosphate moles × 10^5 per 100 ml.	Ammonia moles × 10^6 per 100 ml.	Inorganic phosphate moles × 10^5 per 100 ml.
30,000	1·10	2·70	1·00	0·90
60,000	2·20	5·40	2·00	2·25
90,000	3·25	9·10	3·00	4·00

Table 2. AQUEOUS SOLUTIONS (0·05 PER CENT) OF THYMUS DEOXYRIBONUCLEIC ACID (SIGNER) IRRADIATED WITH X-RAYS (200 kV.)

Dose in r.-units	Yield of ammonia (moles × 10^6 per 100 ml.)		
	In air	In vacuum	In hydrogen
30,000	1·00	0·65	0·45
60,000	2·00	1·35	0·95
90,000	3·00	2·0	1·45

indications as to the chemical nature of the radicals involved. Table 2 shows a representative series of the ammonia yields from thymus deoxyribonucleic acid solutions when irradiated under these various conditions. The figures in air are again included for comparative purposes.

The yield of ammonia progressively decreases on changing the irradiation conditions from air to vacuum and to hydrogen. This same sequence was also observed in the case of yeast ribonucleic acid solutions and again when the base, adenine, was employed as substrate. From these facts, therefore, we conclude that the attack on the bases in the nucleic acid is predominantly by an oxidative radical, for example, hydroxyl. The highly viscous character of thymonucleate solutions may be due in part, as suggested by Gulland[7], to the existence of hydrogen bonding between amino- and hydroxyl-groups. The attack of the hydroxyl radicals on the base, with the subsequent liberation of the amino-group, will most likely destroy this particular type of bonding; this process could conceivably account for part of the viscosity loss as observed on irradiation of these solutions.

Determinations of the inorganic phosphate formed under the various conditions outlined above yield results which lead us to the conclusion that the *hydrogen atoms* (which are simultaneously produced with the hydroxyl radicals in the primary process (equation 1)) may also play some part in the degradation of the nucleic acid. Irradiations of thymus deoxyribonucleic acid solutions, for example, give yields of inorganic phosphate, some values of which are recorded in Table 3.

Table 3. AQUEOUS SOLUTIONS (0·05 PER CENT) OF THYMUS DEOXYRIBONUCLEIC ACID (SIGNER) IRRADIATED WITH X-RAYS (200 kV.)

Dose in r.-units	Yield of inorganic phosphate per 100 ml. (moles × 10^6)		
	Air	Vacuum	Hydrogen
30,000	0·90	1·15	1·45
90,000	4·00	4·80	6·55
150,000	8·80	9·85	14·30

The yields of inorganic phosphate in an atmosphere of hydrogen are somewhat higher than the corresponding yields in either air or vacuum. This behaviour suggests that the hydrogen atoms are capable of effecting a dephosphorylation. Although the exact interpretation of this phenomenon is not yet clear, an interesting analogy arises from the work of Atherton, Openshaw and Todd[8], who have demonstrated the hydrogenolysis of certain phosphate esters (for example, dibenzylphosphate) by means of hydrogen in the presence of palladized charcoal at room temperature.

All these experiments, therefore, show that even with doses approaching those of biological significance the degradation of nucleic acids by X-rays is of a chemical nature. These chemical changes are a manifestation of the attack by the free radicals,

hydroxyl and hydrogen atoms, which are both effective under suitable conditions.

Full details of this work on the chemical action of X-rays on aqueous solutions of the nucleic acids, as well as on the nucleotides, the nucleosides and the purine and pyrimidine bases, will be published elsewhere.

Our thanks are due to Prof. R. Signer (Berne) for the generous gift of thymus nucleic acid.

[July 26.

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KINETICS AND MECHANISM OF DIAZOTIZATION

By Prof. E. D. HUGHES, F.R.S.,
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RATES of diazotization have been measured. The classical work of Hantzsch having established high mobility in the system

$$ArNH.NO \longleftrightarrow ArN:N.OH \longleftrightarrow Ar\overset{+}{N}_2\overset{-}{O}H,$$

it has been assumed that the measured rates are those of N-nitrosation, a process which must involve attack by an electrophilic nitrosating agent on the unshared electrons of the amine.

This report relates to diazotization in weakly acidic aqueous solutions of nitrous acid. We have to consider the following as possible nitrosating agents in these conditions:

$$\overset{+}{N}O, \quad NO.\overset{+}{O}H_2, \quad NO.NO_2, \quad NO.OH.$$

The above order is that anticipated for decreasing electrophilic reactivity (OH_2, $\overline{N}O_2$, $\overline{O}H$, being in order of increasing basicity). However, the effectiveness of a reagent will depend jointly on its reactivity and concentration: *a priori*, any of the above reagents might be effective in the conditions employed. Had hydrochloric or hydrobromic acid been present, we would have had to consider NOCl or NOBr as further possibilities. However, this type of complication was avoided by employing perchloric acid as the only strong acid.

It is not possible to associate each of the above nitrosating agents with a single kinetic equation. As to those species, NO^+ and N_2O_3, the formation of which from nitrous acid involves the breaking of a bond (otherwise than by proton-transfer), either the formation of, or the attack by, the nitrosating agent might be rate-determining. There are even two possibilities for a rate-determining formation of NO^+, since it could arise through either $H_2NO_2^+$ or N_2O_3. We assume that the formation of $H_2NO_3^+$ from nitrous acid (by mere proton-transfer) could not be rate-determining. The possible kinetic equations are assembled in the accompanying table.

Agent	Rate-determining formation of agent	Rate-determining attack by agent
NO^+	$v \propto [HNO_2][H^+]$ $v \propto [HNO_2]^2$	$v \propto$ [amine] $[HNO_2][H^+]$
$H_2NO_2^+$	—	$v \propto$ [amine] $[HNO_2][H^+]$
N_2O_3	$v \propto [HNO_2]^2$	$v \propto$ [amine] $[HNO_2]^2$
HNO_2	—	$v \propto$ [amine] $[HNO_2]$

Hantzsch and Schumann[1] first measured rates of aqueous diazotization: they established approximate second-order kinetics, for which they wrote the equation:

$$\text{Rate} \propto [ArNH_2^+][HNO_2]. \qquad (1)$$

This finding was confirmed by Tassilly[2], and again by Boeseken, Blanksma and Schoutissen[3]. In most of this work the concentration of free acid (hydrogen ion) was not above 0·01 *N*.

Later, Schmid and Muir[4] investigated the aqueous diazotization of aniline with concentrations up to

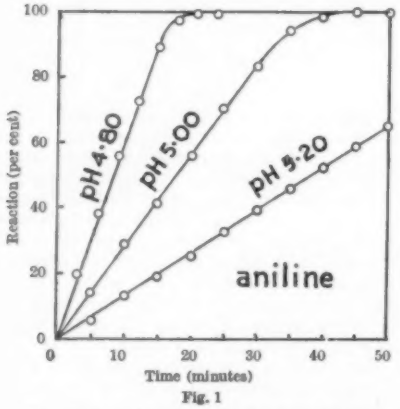

Fig. 1

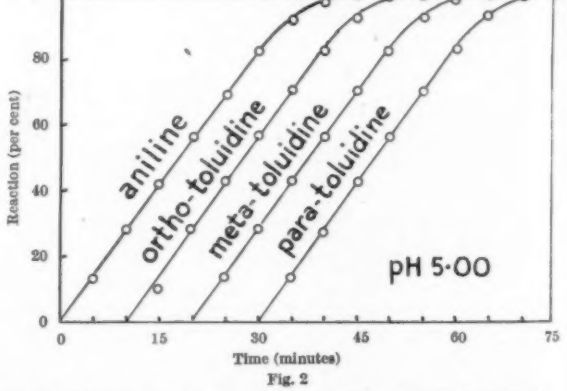

Fig. 2

Diazotization of amines with nitrous acid in excess at constant pH in water at 0°. Initially, $[ArNH_3ClO_4] = 0·0005$ *M*, $[NaNO_2] = 0·01$ *M*, phthalate buffer 0·05 *M*, throughout. Fig. 1. Aniline at various pH values. Fig. 2. Various amines at pH 5·0 (plotted for convenience as if started at 10-min. intervals)

0·3 N of free sulphuric acid. They observed third-order kinetics :

$$\text{Rate} \propto [\text{amine}]\,[HNO_2]^3. \qquad (2)$$

They seem to have been unaware of the earlier work, and to have assumed that their equation would apply at the lower acidities (a misconception which appears in several modern text-books). Equation (2) is identical with T. W. J. Taylor's equation for the action of nitrous acid on aliphatic primary and secondary amines[5]. This is satisfactory, since Austin has shown[6] that the deamination of aliphatic primary amines almost certainly proceeds through a diazonium compound : all these reactions depend on N-nitrosation.

As to the interpretation of the third-order equation (2), two main suggestions have been made. One, due to Kenner, assumes[7] that the second nitrous acid molecule is required to supply a nitrite ion, which is needed in order to extract a proton from the reaction complex. This has been disproved by Austin[6], who has shown that other anions, comparable in basic strength to the nitrite ion, have no effect on the reaction. The other suggestion, due to Hammett[8], recognizes that the third-order kinetics of equation (2) would agree with a rate-determining attack by N_2O_3. However, there can be no settled conclusion so long as the second-order kinetics applying to the lower acidities cannot be accommodated : hitherto this difficulty has been ignored.

Consistently with the results of the earlier workers, we have found that, in the aqueous diazotization of aniline in the presence of perchloric acid, the overall reaction-order does indeed drop, substantially from 3 at acidities above 0·05 N, to 2 at acidities below 0·002 N. But we have also found that the order 2 does not consist, as those investigators assumed without proof, of an order of 1 with respect to each reagent ; it consists of the order 0 with respect to the amine, and the order 2 with respect to nitrous acid. The true equation for low acidities is as follows :

$$\text{Rate} \propto [HNO_2]^2. \qquad (3)$$

This key result may be illustrated. One way of demonstrating a zeroth-order reaction with respect to the amine involves keeping the concentration of nitrous acid constant. We have to remember that, in equations (2) and (3), "amine" means the free base, and "HNO_2" means the non-ionized acid. We can keep the concentration of non-ionized nitrous acid constant by having the stoichiometric nitrous acid in large excess, and then buffering with respect to pH. This last proceeding maintains the non-ionized nitrous acid as a constant fraction of the stoichiometric nitrous acid ; it also renders the free amine a constant fraction of the stoichiometric amine. Some linear reaction – time curves, illustrating zeroth-order diazotization under these conditions, are shown in Figs. 1 and 2. Evidently the rates are independent of the concentration of the amines, in the region of acidity illustrated ; and they are independent of the nature of the amines over the range shown. From the dependence of rate on the stoichiometric concentration of nitrous acid and on pH, it is easily deduced that the order with respect to molecular nitrous acid is 2.

The conclusion is obvious (see table on p. 642). Equations (3) and (2) jointly establish N_2O_3 as the nitrosating agent. At quite low acidities, the concentrations of free amine are large enough to secure that the N_2O_3 shall be destroyed as fast as it is formed. Thus the zeroth-order rates are those of the formation of N_2O_3 from nitrous acid. At the higher acidities, there is so little free amine that the N_2O_3 is able closely to approach its equilibrium concentration. The evidence is entirely parallel to that adduced by Hughes, Ingold and Reed[9] for nitration by NO_2^+, and by De la Mare, Hughes and Vernon[10] for chlorination by Cl^+.

Equation (3) alone might have suggested nitrosation by NO^+, formed through N_2O_3 ; but the change-over to equation (2) at the higher acidities excludes this interpretation : nitrosation in our conditions is by non-ionized N_2O_3. On the other hand, at really high acidities, we may expect to observe nitrosation by NO^+ or $H_2NO_2^+$: a report relating to such media will be offered later. [May 5.

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TENTH INTERNATIONAL ORNITHOLOGICAL CONGRESS

AT the first International Ornithological Congress, held in Vienna in 1884, it was reported that "it was attended by representatives of almost all civilized countries, except England and America, ornithologists even coming from such distant lands as Brazil, Hawaii and Siam". At the Tenth International Ornithological Congress, held sixty-six years later in Uppsala in June last under the presidency of Dr. Alexander Wetmore (United States), there were seventy-nine members from the British Isles and thirty-three from the United States of America. Though Brazil, Japan and Hawaii and Siam were not represented, ornithologists from such far distant countries as Venezuela, New Zealand and India were present.

As this was the first Congress since the War, the last having been held in Rouen in 1938, it speaks much for the ability of the organising secretary, Prof. Sven Horstadius, of the Zoologiska Institutionen, Uppsala, and president of the Svenska Ornitologiska Förening, that he was able to bring together 370 ornithologists from twenty-seven different countries. Meeting in a neutral country in the pursuit of a common interest, the bitterness of recent years was obliterated, as was evidenced by the large representation from Germany, a country which has always been to the forefront in the science of ornithology, and the fact that Russian ornithologists sent a long telegram of good wishes and regrets that their own ornithological meetings prevented their participation.

The programme of papers read at the Congress showed the change in aspect of the approach to the study of birds, for while at the beginning of the century emphasis was on systematics and taxonomy, the modern trend is towards the study of migration, behaviour, ecology and population dynamics.

Though the president chose palæontology as the subject of his opening address, "Recent Additions to

our Knowledge of Prehistoric Birds", there were only two other papers on this subject, "Moa Deposits on Pyramid Valley Swamp, New Zealand", by Dr. R. Murphy (United States), and "Eine Rekonstruktion des Schädels des *Archæornis siemensi* Dames" (with demonstration), by Dr. A. Kleinschmidt (Germany). Dr. E. Sutter (Switzerland) on "Wachstum und Differenzierung des Gehirns bei Nestflüchtern und Nesthockern" was the sole contributor on bird anatomy.

There was a larger number of papers on systematics and evolution, including "Der Einfluss philosophischer Naturbetrachtung auf die ornithologische Systematik" by Prof. Erwin Stresemann (Germany), "Bird Speciation" by Dr. Ernst Mayr (United States), "Systématique des Turdidés" by J. Dorst (France), "On some Phylogenetic Trends in *Garrulus glandarius* and *Dendrocopus major*" by Dr. J. M. Harrison (Great Britain), "Races of the Bean Goose (*Anser fabalis*) in Western Europe" by R. A. H. Coombes (Great Britain), and "Nomenclature, Genetics and Classification in Guinea Fowls" by Prof. A. Ghigi (Italy).

Bird migration and orientation were the subjects of no less than twenty papers, including a general review of bird migration by Prof. Rudolf Drost, director of the Vogelwarte, Heligoland. The Section on Population Dynamics, which opened with a paper on "Population Ecology" by Dr. David Lack, had fourteen other papers, ranging from "Control of the Herring Gull and the Cormorant on the New England Coast" by Dr. A. O. Gross (United States) to "Census of Swedish Rookeries" by T. Malmberg (Sweden).

Dr. N. Tinbergen (Holland) opened the Section on Bird Behaviour with a report on recent advances in this subject, and was followed by six papers, three of which were illustrated with films.

An innovation was a full-day round-table conference on bird ringing presided over jointly by Dr. A. Landsborough Thomson (Great Britain) and F. C. Lincoln (United States). The quality and types of rings, methods of presenting reports of recoveries, and closer collaboration between ringing organisations were among the points discussed, and a permanent committee was set up to facilitate the exchange of ideas.

At the opening meeting of the Congress an introduction to Swedish ornithology was given by Prof. Sven Horstadius, and colour films of Swedish wild life were shown by Bertil Haglund.

Every evening, films on various aspects of ornithology were shown, those of the most outstanding interest being one of the rediscovered *Takahe* (*Notornis*) by Dr. R. A. Falla (New Zealand), which was shown on his behalf by R. B. Sibson, and Prof. A. A. Allen's colour film of the bristle-thighed curlew.

During the Congress various excursions were made, one by boat to the archipelago off Norrtälje, and another, starting at midnight, to the forests of Uppland. Linnæus's house at Hammarby, and old Uppsala, were also visited. A final banquet, given by the Svenska Ornitologiska Förening in the Great Hall of the Vasa Castle, presided over by the Governor of the Province of Uppsala, Mr. H. Kjellman, followed by Swedish student songs and folk dances performed by the students of the University, was an occasion of unique charm and impressiveness that will never be forgotten by the many foreigners present.

Both before and following the Congress, most efficiently organised field excursions were made to various parts of Sweden, some members going to Kiruna and Abisko in Lapland, others to the mountains and lakes of Jamtland, and to Narke and Varmland in the lake district of central Sweden, while yet others visited the islands of Göttland and Öland. The recently established ringing station at Ottenby on the island of Öland showed the great work being done in this direction by Swedish ornithologists.

The Eleventh International Ornithological Congress will be held in Switzerland in 1954, under the presidency of Dr. A. Landsborough Thomson, who is president of the British Ornithologists' Union.

CHESS-PLAYING MACHINES

AN article entitled "Programming a Computer for Playing Chess", by Dr. C. E. Shannon, of the Bell Telephone Laboratories, which appears in the March issue of the *Philosophical Magazine* (41, 256; 1950) will doubtless interest many chess players as well as those concerned with electronic computing. The paper was originally presented at the National I.R.E. Convention in New York in March 1949 and deals with the theoretical problem of constructing a computing routine or 'programme' for a modern general-purpose computing machine. Dr. Shannon himself was one of the contributors to the recent symposium on information theory held in London during September 26–29.

It will be recalled that in recent years Dr. D. W. Davies, of the National Physical Laboratory, built an electro-mechanical machine for playing the game of noughts-and-crosses[1], and this machine was exhibited at the Royal Society conversaziones of 1949. But though machines for chess and noughts-and-crosses may be of theoretical interest only, the theoretical problems involved are of similar nature to those which would occur in designing machines for more practical purposes, such as those which have already been seriously proposed, namely: for the routing of telephone calls based on individual circumstances rather than by fixed patterns; for the performance of symbolic (non-numerical) mathematical operations; for translating from one language to another; for making strategic decisions in simplified military operations; and for the orchestration of a melody. Machines of this type are, as Dr. Shannon points out, an extension over the ordinary use of numerical computers in several ways, for the entities dealt with represent not numbers but chess positions, mathematical expressions, words, etc. Something of the nature of judgment is involved, and the solutions are not merely right or wrong but choose some form of quality between the best and worst solution.

Chess-playing machines are not new, and Dr. Shannon refers briefly to the considerable literature on the subject. He mentions the Maezel chess automaton invented by von Kempelen, which was undoubtedly operated by a concealed chess master. The chess-playing machine made in 1914 by Torrès y Quévedo[2], the director of the Laboratorio de Automática in Madrid, was an honest attempt and could play an end-game of king and rook against king. This involves a comparatively simple problem, since in this particular end-game any one of the opponent's moves can be countered by the machine by one of five basic moves.

With chess, Dr. Shannon states, it is, in principle, possible to play a perfect game or to construct a machine to do so; but even with the high computing speeds of modern electronic calculators it is not a practicable proposition, since, taking an average game of about forty moves, there would be 10^{120} variations to be calculated from the initial position. This would require some 10^{90} years for the calculation of the first move. The problem is therefore not of designing a machine to play perfect chess, or even legal chess, but a skilful game comparable to that of a good human player. Dr. Shannon outlines several possible 'strategies', that is, the processes for choosing a move in a given position, and discusses the methods of programming for them. He contrasts clearly the advantages and disadvantages of a machine over the human player. The machine can perform individual calculations at extremely high speeds; it is free from errors and laziness and does not suffer from nerves, but it lacks the flexibility, imagination and inductive and learning capacities of the human mind. No machine can learn from its mistakes—to improve the play the programme must be improved; but the speed and accuracy of the computer is such that a little careful selection in the 'strategy' goes a long way toward improving on blind trial and error.

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ROYAL PHOTOGRAPHIC SOCIETY

ANNUAL EXHIBITION

THE ninety-fifth annual exhibition of the Royal Photographic Society was opened in London on September 15 for one month and will be in Newcastle from October 25 for a further month. The exhibition consists of seven sections, including pictorial, scientific, nature and record photography, with a total of 705 exhibits.

There were only some dozen or so exhibits of general scientific interest, the remainder in this section being of medical or biological application. An excellent series of exhibits is shown by the National Physical Laboratory, among which are a number of radiographs obtained by means of the Van de Graaff X-ray generator to illustrate its value for this type of work. The apparatus has an extremely small focal spot and enables enlarged radiographs to be made simply by placing the film some distance behind the subject, instead of close to it as in normal procedure. The images obtained were sharp, and in addition had a higher contrast than normal due to the smaller effect of scattered radiation. Also from the National Physical Laboratory are some Schlieren photographs taken of an aerofoil in a supersonic wind tunnel; by the application of polarized light, a pair of transparencies illustrate how compression or shock waves can be distinguished from rarefied waves by a change in colour of the air-wave images. Photographs of a scale model of the Bankside Power Station and St. Paul's Cathedral in a low-velocity wind tunnel show how the original height of the smoke stack had to be increased in order to prevent damage to the dome of the Cathedral by continued action of the smoke.

The perfection of the surface of small objects, such as steel ball bearings, is illustrated by the use of the Linnik interference microscope. The actual depth or degree of any scratches or other imperfections can more readily be estimated by observing the displacement of interference fringes than by simple microscopical examination.

The use of the ultra-violet microscope (2536 A.) in the three-dimensional study of human chromosomes, by E. W. Mitchell, is well shown in a series of photomicrographs of the same subject taken at 0·5-micron steps through its depth. At the very small depth of field possible with the wave-length used, a series of images, each in its own plane and each slightly different from the next, is produced, thus enabling a solid model to be pictured.

A number of aerial photographs submitted by Hunting Aerosurveys, Ltd., illustrate how these can aid ground survey in the interpretation of geological structure and land utilization.

The greater part of the medical exhibits are concerned with the illustration of pathological conditions, but three entries from the University of Zurich concerned with photographs of the eye deserve special mention, particularly one illustrating detachment of the retina.

As one passed into the Nature Photography Section, one could not but be impressed by the fact that the technical excellence and artistic merit of the majority of exhibits might well admit them to the Pictorial Section, apart from their value as biological studies. A surprisingly large number of exhibitors appeared to prefer owls as their favourite subject-matter. One could not, for example, fail to enjoy the series "Little Owls" by R. Jones and observe the pithy mood, the haughty mood and finally the furious mood shown by these youngsters. There are several exhibits showing the life-history of various insects, the "Transformation of Painted Lady Butterfly" by Gordon F. Woods being a good example. The pictures of a "Green Grass Snake swallowing a Toad" in four stages (O. C. Edwards) can scarcely fail to induce a touch of indigestion in the observer. D. P. Wilson's "Scallops escaping from Starfishes" makes an excellent example of Nature's perpetual struggle. One of the ugliest animal pictures must be "Bull and Sea Elephants" by Niall Rankin, but the cumbersome appearance of these animals offsets to an extreme the daintiness portrayed in such a picture as "Fallow Deer" by W. Farnsworth.

In the Record Section of the exhibition, first mention must be given to L. E. Day, for his entry "Morse to the Bishop's Cope, Norwich", for which he was awarded a Royal Photographic Society medal. The Record Section is subdivided into archæological and architectural, news, advertising and industrial sub-sections. Among the 'news shots' is a fine night scene, "London's Bailey Bridge Falls Down", by F. Greaves; and the photograph "Family Group", by H. R. Matthews, provides a fine study in light and shade as well as advertising a set of glazed earthenware jugs. In a picture like "Forging the Link", by W. A. Wood, one cannot fail to be impressed by the concentration of the craftsman working in steel, which provides a worthwhile example of industrial photography.

Finally, half a dozen of William Henry Fox Talbot's original 'calotypes' are exhibited, most of which must have been about a hundred years old, and which make a very fitting standard by which to assess the changes that have occurred in the progress of photography since his day.

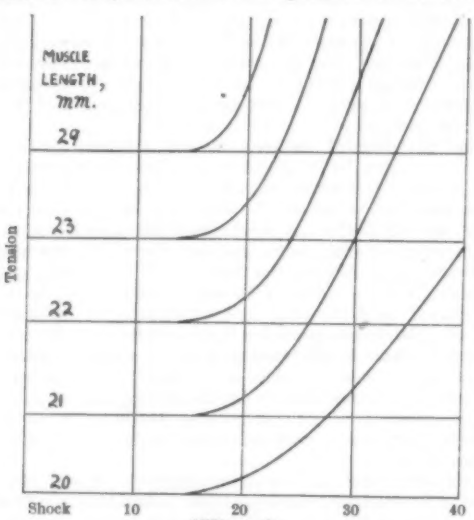
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Is Muscular Relaxation an Active Process?

When a single shock is applied to a muscle it contracts and relaxes; at constant length its tension rises and then falls, and under constant load it shortens and then lengthens. It has long been debated whether relaxation is an active or a passive process, whether lengthening after shortening is due to some positive internal activity, or merely to the effect of the external load in drawing the muscle out as its active contractile state disappears and its resting plasticity returns. Several independent observations (see ref. 1) favour the second view: (1) no heat is produced in relaxation, except such as can be attributed to the mechanical energy of the falling load; (2) over a wide range of lengths less than the normal length in the living animal, a resting muscle after relaxation shows a small but measurable tension; and (3) over this range of lengths the mechanical latent period (the interval between stimulus and onset of contraction) is practically constant. The latent period is an extremely sensitive index of 'slack', for shortening, particularly at shorter lengths, is relatively slow. If the muscle, or its fibres, or its ultimate contractile linkages, lengthened after a previous contraction, the slack would have to be taken up after the next stimulus and the latent period would be greatly extended.

Recent improvements in technical detail have provided convincing evidence of the constancy of the latent period at all lengths. The accompanying graph is a direct copy of a single plate on which the early stages of five isometric twitches were recorded at high constant sensitivity and speed. A frog's sartorius (98 mgm., 31 mm. long in the body) rested in Ringer's fluid at 0° C. in contact with a 'Perspex' plate in which were inlaid a number of thin silver wires, the surface being milled flat and polished so as to be as frictionless as possible. The silver wires were for stimulating, numbers 1, 3, 5 . . . joined together being the anodes of a super-maximal condenser discharge, numbers 2, 4, 6 . . . the cathodes. This multiple-electrode arrangement ensures that the whole muscle is excited simultaneously. The muscle was held by a clamp at the acetabulum, and an oiled linen thread, tied to the tendon, passed up vertically to a sensitive electrical tension recorder. The system was very carefully levelled, so that the muscle and thread lay in a vertical line: adjustment was continued until the thread showed no lateral wobble when the muscle was stimulated, which ensured that there was no slack between muscle and recorder. These details are important, since a very small amount of slack greatly prolongs the latent period and makes the take-off less definite.



Sartorius of frog, 31 mm. long in body, 98 mgm. Isometric twitches at various lengths. Temperature 0° C. Shock: condenser discharge, RC = 1·1 msec., at multiple electrodes. Preliminary shocks at 18 mm., then one each at 20, 21, 22, 23 and 29 mm.

In the experiment shown, the muscle was set at length 18 mm. and a few preliminary shocks were applied. It was gently stretched to 20 mm. by raising the recorder, and the bottom twitch was recorded. It was then stretched successively to 21, 22, 23 and 29 mm. and a twitch was recorded at each length. The shortest length, 20 mm., is only about 65 per cent of the length in the body, far less than ever during life. It is evident, however, that the latent period is the same within about 1 msec. over the whole range. At the shorter lengths the maximum velocity of shortening, even when the contraction had been fully developed, could not have been more than about 10 mm./sec., or 0·01 mm./msec. Thus, there cannot have been more than 0·01 mm. slack at any length.

It might be objected that the muscle was prevented from lengthening freely during relaxation by sticking to the 'Perspex plate'. This objection is met as follows: (1) the plate was smooth and the line of the thread was parallel to it; (2) the muscle was in Ringer's fluid; (3) if the muscle as a whole were prevented from lengthening that need not hinder its fibres, or their contractile linkages, from going into folds and so providing slack, were there an active tendency to lengthen; and (4) if contact with the plate hindered lengthening, it would presumably hinder shortening also, and irregularities due to stickiness would be evident on the tension records; in fact, however, if such irregularities occur they are certainly less than 1 mgm., that is, about 1/40,000 of the maximum tension developed by the muscle.

The frog's sartorius is made up of long straight parallel fibres with a minimum of connective tissue. Muscles of complex anatomical structure might show a different result, not because their contractile elements are different, but because elastic constraint might force the relaxing fibres to lengthen. The accompanying graph, however, shows that a muscle with straight parallel fibres may remain taut, after contraction, even at quite short lengths. Such a muscle lengthens in relaxation only if an external force is applied.

In a recent letter, Katchalsky and Eisenberg[2] refer to a model of muscle consisting of a polyvinyl phosphate thread which contracts strongly in concentrated acid and expands rapidly to its original length when returned to distilled water or dilute alkali. It would be interesting to know whether this expansion still occurs in the absence of any external force on the fibre.

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Active Relaxation of Unstriated Muscle

Ramsey and Street[1], working on single muscle fibres, concluded that relaxation in skeletal muscle was active. Prof. A. V. Hill[2] has conclusively shown that relaxation in skeletal muscle is passive. We stimulated the frog's rectus abdominis with potassium salts and acetylcholine and did not find any active relaxation. In unstriated muscle relaxation is active under some conditions and passive under others[3–5]. In unstriated muscle there would appear to be two cycles: in one, the energy for contraction is derived from chemical stores; in the other, the energy for contraction is derived from energy previously stored in the structure. Striated muscle appears to possess the former cycle only. This, we think, is the fundamental difference between the two kinds of muscle.

The nature of one kind of tonus in unstriated muscle follows as a corollary to the above. It is due to interference with active relaxation[3,4]. This is supported by oxygen-consumption experiments, there being less oxygen consumed during contraction and more during relaxation[6]. Estimations of lactic acid also support this[7]. Oxygen or glucose causes the muscle to relax, or increases relaxation during inhibition[8,9], asphyxia, cyanide or iodoacetic acid increasing the tonus. It is interesting to note that acetylcholine and adrenaline cause contraction and relaxation also by direct action on the contractile mechanism[10]; sodium and calcium ions cause contraction, whereas potassium ion causes relaxation by similar action. Histamine causes contraction. These findings may be of importance in connexion with the contraction and relaxation of the actomyosin system. For twitch contraction and inhibition, substances which are readily destroyed would be required; these may well be acetylcholine and adrenaline. For tonic contraction and inhibition, a permanent substance is required; this is presumably an ion[10]. It is interesting to note that acetylcholine is necessary for the contraction of the heart muscle[11].

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Effects of Hypo- and Mild Hyper-thyroidism on Fleece-Growth in Sheep

A REVIEW of the available literature on the subject of wool biology shows that practically no systematic work has been done so far on the role of various hormones on wool growth. Since the thyroid hormone regulates about 40 per cent of the energy metabolism in sheep and the growth of wool is influenced by the plane of nutrition[1], as well as by other factors, an investigation was undertaken of the effects of varying levels of thyroidal stimulation or inhibition on wool growth in the growing sheep.

Eight Suffolk male lambs about 4–4½ months old were used in the present experiments, and they were divided with regard to age and body-weight into three groups. The lambs in group No. 1 were given daily 'Protamone' (thyro-active iodinated casein) in the ration, within the physiological range, and the lambs in group No. 2 were either given daily sufficient doses of a goitrogen (for example, thiouracil) or thyroidectomized, while group No. 3 was kept as control. All the animals were kept under the same environmental and feeding conditions. After 5½ months of treatment, wool samples were taken from each ram every month for four consecutive months, the animals being kept on the same treatments throughout the experimental period. All the animals were weighed and their rectal temperatures recorded weekly during the first half, and fortnightly during the second half, of the experimental period. The animals in a mild hyperthyroid condition showed greater gain in body-weight than the controls; but their rectal temperatures did not differ significantly from those of the controls[2].

Examination of the wool samples showed that mild hyperthyroidism resulted in an increase, while hypothyroidism resulted in a decrease, in the fibre-length when compared with the control group. In both the hypo- and hyperthyroid sheep the fibre diameter was not affected. The fleece in one of the hypothyroid sheep was comparatively easily pluckable and the crimps were less distinct when compared with the control.

Thyroidectomy performed in the young merino sheep does not show any effect on the wool fibre diameter[2].

How thyroidal stimulation influences wool growth in the growing sheep needs further investigation; but it may be that the thyroid hormone, by increasing the body metabolism with anabolic effects, stimulates wool growth. In the hypothyroid sheep, the marked decrease in the basal metabolic rate might have interfered with the normal fleece growth. These results will be described in detail elsewhere.

I am indebted to Dr. J. Hammond and Dr. Arthur Walton for providing facilities in their laboratories, to Dr. Sven Skärman, Wool Laboratory, Waid, Sweden, for sectioning the wool samples, and to Dr. A. B. Wildman, Wool Industries Research Association, Leeds, for valuable suggestions.

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Uptake of Phenothiazine Labelled with Sulphur-35 by the Tissues of Nematode Parasites and their Hosts

PHENOTHIAZINE has a very low solubility, a low toxicity for host animals, and a high dose-rate when used as an anthelmintic. Its anthelmintic action varies among even closely related species of nematodes; *in vitro* it has little activity. Explanations for these characteristics have been sought by following the uptake and retention of phenothiazine labelled with sulphur-35 by host and parasite tissues. This

method has proved suitable for following phenothiazine and its derivatives formed in animal tissues. No evidence has been obtained that sulphur is freed from phenothiazine by the action of biological systems. The 'phenothiazine' determined in animal tissues and referred to in this communication includes the unchanged compound and its sulphur-containing derivatives formed in the tissues.

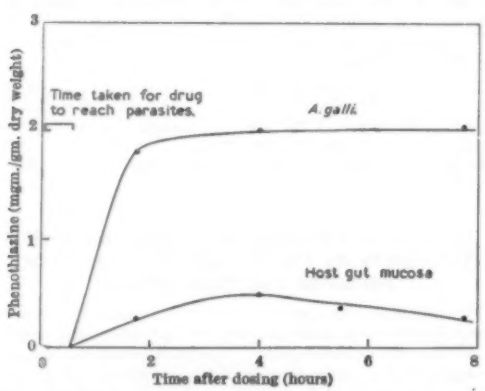
The error in the chemical and physical procedures used was less than ± 10 per cent; but variations in the results obtained *in vivo* were often greater than this, due probably to the variations in the conditions and the rate of passage of the drug in the alimentary tract.

The rate of uptake of labelled phenothiazine *in vitro* by three nematode species is shown in the accompanying table.

Species	pH	Phenothiazine (mgm./gm. dry wt./hr.)	Relative surface area of the parasites per unit wt.
	(mean values from three experiments at 37° C.)		
Haemonchus contortus	5·0	0·27	11
Nippostrongylus muris	6·8	0·18	19
Ascaridia galli	6·8	0·12	1

The rate was constant with time; it varied with the species but not in proportion to their relative surface areas. Uptake by *Ascaridia galli* reached a peak at *p*H 6·0 and was further increased in the presence of wetting agents.

The parasites took up the drug four to ten times more rapidly *in vivo* than *in vitro*. The distribution of the drug in the tissues of *Ascaridia galli* measured as the ratio of the amounts of phenothiazine in cuticle and muscle, female reproductive system, and intestine was about 1 : 3 : 4 after 28 hours *in vitro*, and about 1 : 3 : 6 after 2 hours exposure *in vivo*. Ligaturing male *Ascaridia galli*, to prevent the entry of the drug through the orifices of the alimentary canal and sex organ, did not appreciably affect the rate of uptake. As the parasites probably did not feed on the medium *in vitro*, these results give no indication as to whether the drug was taken up via the alimentary canal of the parasites *in vivo*. However, they showed that the cuticle of the parasite was permeable to the drug. Esserman[1] has shown that the rate of appearance of phenothiazine labelled with sulphur-35 in the tissues of *Ascaris lumbricoides* exposed to the drug *in vitro* was somewhat slower when the drug was injected into the alimentary tract of the parasites than when it was taken up through the cuticle. The nature of the feeding habits of the parasites *in vivo*[2] suggests that entry via the cuticle may be the important route.



Uptake of labelled phenothiazine by *Ascaridia galli* and host gut mucosa. A period, ½–¾ hr. after dosing, which elapsed before the drug reached the parasites in the host intestine, is indicated in the graph

The rate of uptake by *Ascaridia galli* and by the adjacent mucosa of the host's gut is shown in the accompanying graph. The amount found in the host's blood, liver and intercostal muscle was somewhat similar to that in the gut mucosa. *Nippostrongylus muris* took up phenothiazine in a manner similar to *Ascaridia galli*. The course of uptake in the tissues of the rat was like that in the chicken, though the amount found was usually smaller.

Parasites which had been exposed to phenothiazine *in vivo* and which had been expelled from the host by its action remained alive *in vitro* as long as untreated parasites and retained a large proportion of the drug when incubated in phenothiazine-free medium. It seems likely that the phenothiazine was also retained for a considerable period by parasites which were not expelled from the host; in one experiment, in which some *Ascaridia galli* were not expelled by the anthelmintic within twenty-four hours after dosing, phenothiazine was still present in the parasites up to a concentration of 0·59 mgm. per gm. dry weight, though no appreciable amounts could be detected in the host's intestinal mucosa.

Ascaridia galli which had been expelled from the host by the action of the drug contained 1·64–3·30 mgm./gm. dry weight (average of seven determinations, 2·47 mgm./gm.). *Nippostrongylus muris*, though not expelled by the drug, took up as much as 3 mgm./gm. dry weight at times, and for periods of six hours at least, contained amounts of about 1·50 mgm./gm. dry weight.

The results given show a differential selection of the drug by the susceptible parasite relative to the host. However, the difference in uptake between the susceptible parasite, *Ascaridia galli*, and the unsusceptible parasite, *Nippostrongylus muris*, is not sufficient to account for the differential toxicity to these organisms. The failure of phenothiazine, though retained in the tissues of *Ascaridia galli*, to limit survival *in vitro* also needs explanation.

Though there are considerable differences in the nutrition and metabolism *in vivo* of *Ascaridia galli* and *Nippostrongylus muris*[2,3], studies on the nature of oxidative mechanisms in nematode parasites[4] suggest that when maintained aerobically *in vitro* some of the differences between parasites may disappear. It remains to be determined whether these results can explain the selective action of phenothiazine as an anthelmintic *in vivo* or its lack of activity *in vitro*.

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Synthesis of Serine by Micro-organisms

For some years there has been indirect evidence (reviewed, for example, by Woods[1]) that *p*-aminobenzoate has a function in the synthesis by micro-organisms of certain nucleic acid components and amino-acids. In the case of the former substances it is probable that the effect occurs through the intermediate formation of folic acid (pteroylglutamate) or related compounds which contain a *p*-aminobenzoate residue. One of the amino-acids implicated above is serine[2], and this was chosen for the present studies since Sakami[3], working with animal tissues, has shown its formation by condensation of glycine with a one-carbon compound such as formate. There is also evidence with several micro-organisms that glycine is a precursor of serine[4,5]. Holland and Meinke[6] have found that under certain limited conditions *Streptococcus faecalis* R requires serine for growth, and that such requirement may be largely abolished by increasing tenfold the concentration of pteroylglutamate.

We have found with growing cultures of *Leuconostoc mesenteroides* P60 that serine may be partially replaced by glycine in the presence of pyridoxal and carbon dioxide, and that the replacement is almost total on the further addition of *p*-aminobenzoate. These observations enabled us also to apply a suitable assay for serine in the presence of excess glycine, and to study its synthesis from glycine and formate by cell suspensions of *Strep. faecalis* R. In this simplified system, pteroylglutamate was found to be essential and pyridoxal highly stimulatory.

Growth experiments (*L. mesenteroides*). The amino-acid basal medium used was essentially that of Steele, Sauberlich, Reynolds and Baumann[7], with 0·5 gm./l. DL-alanine. Some glycine (*c.* $2{\cdot}5 \times 10^{-4}$ *M*) is necessary for optimal growth even in the presence of serine. Table 1 shows that in its absence full growth is obtained with a forty-fold increase in glycine provided that pyridoxal, carbon dioxide and *p*-aminobenzoate are present. The effect of the first two factors is absolute; omission of *p*-aminobenzoate always reduced growth, often to one-half. Citrate, though not formate, will replace carbon dioxide to a limited extent. Pyridoxal also stimulates slightly in the presence of DL-serine, but neither carbon dioxide nor *p*-aminobenzoate affects growth significantly under these conditions.

Synthesis by cell suspensions. Cells of *Strep. faecalis* R deficient in both folic acid and pyridoxal were obtained from cultures in which these factors were replaced by thymine, purines and DL-alanine. The washed cells were incubated in phosphate buffer *p*H 6·9 (0·1 *M*) and the substances indicated in Table 2. The suspensions were finally autoclaved and serine was assayed in the supernatant fluid with *L. mesenteroides*, using the medium containing *p*-aminobenzoate, pteroylglutamate and pyridoxal with incubation in air or hydrogen; as shown above, even high concentrations of glycine do not then interfere. The standard was synthetic DL-serine. The effect, in a typical experiment, of omitting various components of the complete system is shown in Table 2. Both pyridoxal and pteroylglutamate are needed for optimal synthesis, the effect of the latter being almost absolute. The rather greater activity of formylpteroylglutamate compared with equimolar pteroylglutamate has been observed repeatedly (for example, 1·0, 0·92 and 1·39 compared with 0·76, 0·67 and 1·07 μM serine respectively). Vitamin B_{12} (0·2 μgm.) did not replace pteroylglutamate. Little serine was produced in the absence of glycine, formate or glucose.

Table 1. Growth Experiments with *L. mesenteroides*

DL-serine (10^{-4} *M*)	Glycine (× *M*)	Carbon dioxide in atmosphere†	Pyridoxal (2×10^{-7} *M*)	*p*-Aminobenzoate (2×10^{-7} *M*)	Growth* at 42 hr.
−	10^{-3}	+	+	+	20
−	〃	−	+	+	1
−	〃	+	−	+	0
−	〃	+	+	−	14
−	〃	−	−	+	0
−	〃	+	+	+	0
+	$2{\cdot}5 \times 10^{-4}$	+	+	+	20
+	〃	−	+	+	16
+	〃	+	−	+	14
+	〃	+	+	−	18
+	〃	−	−	+	14
−	〃	+	+	+	3

All concentrations refer to the final medium.
* Galvanometer reading, E.E.L. photo-electric colorimeter, neutral density filter; uninoculated medium = 0.
† Incubated in 5 per cent carbon dioxide in hydrogen (+) or in hydrogen only (−).

Table 2. Synthesis by washed cells of *Strep. faecalis*

Pteroyl-glutamate (2×10^{-8} *M*)	Formyl-pteroyl-glutamate (2×10^{-8} *M*)	Pyridoxal (5×10^{-7} *M*)	Other additions	μM serine*/ mgm. dry wt. cells
+	−	+	Glycine, formate, glucose	1·09
−	+	+	〃	1·45
−	−	+	〃	0·07
+	−	−	〃	0·45
Glycine (0·02 *M*)	Formate (0·02 *M*)	Glucose (0·02 *M*)		
+	+	−	Pteroyl-glutamate, pyridoxal	0·22
+	−	+	〃	0·15
−	+	+	〃	0·16
Complete system, boiled cells				0·06

* After incubation, 8 hr. at 37°; 1 mgm. dry wt. cells/ml.

Similar experiments have been carried out with folic acid - deficient cell suspensions of a strain of *Saccharomyces cerevisiae*[8] requiring *p*-aminobenzoate for growth. The amount of serine synthesized was doubled in the presence of *p*-aminobenzoate, whereas pteroylglutamate (which will not replace *p*-aminobenzoate for growth) was inactive.

These results suggest strongly that folic acid derivatives have an essential function in the condensation of glycine and a one-carbon compound to yield serine. This lends support to the current view that folic acid (or, more probably, higher derivatives[9]) may act as coenzymes in transformations involving the addition of one-carbon residues; in this connexion the higher activity of formylpteroylglutamate is possibly of significance. While this work was in progress Plaut, Betheil and Lardy[10] have shown that tissues of folic acid - deficient rats are deficient in power to incorporate the carbon of formate into serine.

Our results also provide strong evidence that vitamin B_{12} derivatives function at this stage of the synthesis of serine. Furthermore, the results with *L. mesenteroides* at least suggest the possibility that carbon dioxide may, in some cases, serve as precursor of the required one-carbon residue and thus may indicate another possible mechanism of carbon dioxide fixation. Lyman *et al.*[11] have found growth of *Lb. arabinosus* and *Strep. faecalis* R in the absence of serine to be increased by vitamin B_{12}; certain other amino-acids (not serine) were found to be replaced completely by this vitamin plus carbon dioxide. With

L. mesenteroides, they found no relationship between amino-acids and either carbon dioxide or vitamin B_6.

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The Gram Complex in *Clostridium welchii*

IT has been reported[1,2] that various Gram-positive micro-organisms may be converted into Gram-negative cytoskeletons by extraction with 2 per cent sodium cholate at 60° C. The extract from *Clostridium welchii*, for example, contained mainly magnesium ribonucleate, deoxyribonucleic acid and polysaccharide, while the extract from *Saccharomyces cerevisiæ* was composed chiefly of polysaccharide and magnesium ribonucleate. Cytoskeletons so rendered Gram-negative could be reconverted to Gram-positive forms by treatment under reducing conditions with the cholate extract. The essential component in this replating process was magnesium ribonucleate, and it was shown that magnesium ribonucleate from a variety of sources could be replated on to reduced cytoskeletons of yeast or *Cl. welchii*. When Gram-positive cells were converted into Gram-negative forms by autolysis, the resulting cytoskeletons could not be replated by magnesium ribonucleate. Short autolytic processes were found to result in the liberation into solution of an essentially intact magnesium ribonucleoprotein which possessed the staining properties of the Gram-positive cells themselves. The nucleoprotein could be dissociated into magnesium ribonucleate and a protein—neither of which separately possessed the property of being able to retain the Gram stain, but which, upon recombination under reducing conditions, formed a complex which stained intensely Gram-positive. In the light of these results, it was suggested that an essential part of the Gram complex is a magnesium ribonucleoprotein. Numerous confirmations of these claims and techniques have been received[3,4,5] from workers in various parts of the world, though recently Mitchell and Moyle[6] prefer to regard the essential part of the Gram complex as a hypothetical "*X*/*P* factor". However, inasmuch as the results of Mitchell and Moyle show no content of this as yet ill-defined *X*/*P* factor in *Cl. welchii*, which is one of the most intensely staining Gram-positive organisms, we find it difficult to accept their assumption that this factor is an essential component of the Gram complex.

Since our last communications, we have studied the Gram complex further in the endeavour to ascribe a possible role to other macromolecules such as the deoxy-type nucleic acids and the polysaccharides found in association with the ribonucleoprotein. Further, we have sought to explain the reason for our inability to replate those cytoskeletons formed by autolysis procedures. We have now found that extraction of *Cl. welchii* with 6 per cent sodium chloride for 32 hr. at 60° C. is efficient in rendering the cells Gram-negative. Both the extract and the cytoskeletons show differences from those obtained with 2 per cent sodium cholate extraction. Thus the sodium chloride extract contained ribonucleic acid (2·7 per cent), deoxyribonucleic acid (traces only) and polysaccharide (2·0 per cent) (calculated as a percentage of the dry weight of organisms), while the sodium cholate extract contained ribonucleic acid (10 per cent), deoxyribonucleic acid (2·2 per cent) and polysaccharide (1·4 per cent). Extraction of the Gram-negative cytoskeletons remaining after 6 per cent sodium chloride extraction with 2 per cent sodium cholate gave a further extract which contained ribonucleic acid (7·1 per cent), deoxyribonucleic acid (1·9 per cent) and polysaccharide (1·1 per cent). Cytoskeletons from either the sodium cholate or the sodium chloride extractions could be replated with all three extracts separately to reconstitute Gram-positive forms in each case. We have repeatedly made the observation that, by removal of ribonucleic acid, cells become Gram-negative while still retaining deoxyribonucleic acid in the Gram-negative cytoskeletons. This fact, together with the finding that the Gram-positive state can be restored by extracts containing no more than traces of deoxyribonucleic acid and by magnesium ribonucleate from almost any source, confirms previous observations that in *Cl. welchii*, as in yeast, deoxyribonucleic acid plays no part in the Gram complex.

The new observation that only part of the ribonucleic acid (*c.* 20 per cent in *Cl. welchii*) needs to be removed before the cytoskeletons become Gram-negative is of particular importance, inasmuch as it shows that there is present in the cell large quantities of ribonucleic acid not directly associated with the Gram complex. Thus the objections of Mitchell and Moyle[6] to the theory of magnesium ribonucleate being an essential component of the Gram complex, based on their observation that there appears to be no correlation between ribonucleic acid content and Gram staining, is seen to be without foundation. It was possible to demonstrate nucleal structures in the cells extracted with 6 per cent sodium chloride, but not in those extracted with 2 per cent sodium cholate, and it is most probable that both types of nucleic acid may be concerned in nucleal structures. In regard to the recombination of ribonucleic acid with the cytoskeletons, there did not appear to be any essential difference in that part still residing in the Gram-negative cytoskeletons, inasmuch as a sample later extracted with sodium cholate could readily be replated to restore the Gram-positive character to Gram-negative cytoskeletons from a separate sodium cholate or sodium chloride extraction.

The non-species specific nature of the ribonucleic acid in this recombination with the Gram-negative cells was further demonstrated by the fact that a sample of magnesium ribonucleate extracted from a true Gram-negative micro-organism, *B. coli communis*, was capable of being plated on to Gram-negative, cholate-extracted *Cl. welchii* cytoskeletons to restore the Gram-positive character. This experiment in itself throws grave doubt on the existence of any essential specific Gram-positive 'factor' such as *X*/*P*, as this factor would of necessity be absent from Gram-negatives.

Replating of cells made Gram-negative by autolysis. Cells which become Gram-negative by the action of enzymes such as the ribonucleases or their own autolytic enzymes have, in the past, resisted all attempts to replate them with magnesium ribonucleate. We now, however, have made the important discovery that Gram-negative *Cl. welchii* cytoskeletons produced by autolysis can be replated by the magnesium ribonucleoprotein isolated from the autolysis solution. Furthermore, inasmuch as this complex can be dissociated into nucleic acid and protein, this replating can be achieved in two stages, that is, the protein can first be recombined with the cytoskeletons and then used to 'anchor' the magnesium ribonucleate in the usual way. Other proteins can replace the 'Gram protein' only to a small degree, and we have reached the conclusion, therefore, that the protein is specific in its action. It was particularly noteworthy that *Cl. welchii* cells rendered Gram-negative by the carbohydrase, lysozyme, could not be recombined with magnesium ribonucleate[7] or the Gram nucleoprotein. We are therefore inclined to the view that in the normal Gram-positive cell the Gram nucleoprotein is combined in a specific manner with a polysaccharide and that this acts to form a larger macromolecule. In some measure other closely associated large molecules such as polysaccharides and fatty substances probably act non-specifically to form giant molecules and assist in retaining the maximum amount of the Gram stain. All our investigations, however, confirm our previous conclusions that a magnesium ribonucleoprotein is an essential part of the Gram complex in Gram-positives. Attempts to couple the Gram magnesium ribonucleoprotein to various true Gram-negative cells, both untreated and previously extracted by numerous methods, have failed to add any Gram-positive character. This, we believe, shows that the adsorption of the Gram-positive staining material on the above-mentioned cytoskeletons is due to the presence of specific receptor groups and is not merely adsorption as with any charged particle. It appears, therefore, that one of the essential differences between *Cl. welchii* and the various Gram-negative organisms studied is the presence in the Gram-positive organism of a particular type of protein, which when linked to magnesium ribonucleate is able to retain the Gram stain.

We consider that there are quite profound differences between the proteins in Gram-negatives and those in Gram-positives. We can isolate from *Cl. welchii* cytoskeletons a polysaccharide which contains ester phosphate groups, and we are investigating the significance of this with particular regard to lysozyme action.

Further details of the above investigation will be published in a later communication. We wish to thank the Medical Research Council for a grant in aid of this work.

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Vitamin B_{12} and Antihistamine Activity

Traina[1] has reported that intraperitoneal injections of vitamin B_{12} prevent histamine shock following the intracardiac administration of histamine to guinea pigs. Antagonism between histamine and vitamin B_{12} might be of importance in the assay of histamine in liver extracts, and we accordingly investigated this relationship. We have tried to repeat Traina's work, and have also studied the effect of prior administration of vitamin B_{12} on the reduction of arterial blood pressure in the cat after intravenous injection of histamine.

'Histamine Shock.' In the first experiments we attempted to reproduce as closely as possible the conditions described by Traina.

Eight guinea pigs were distributed into two groups of four. Group 1, used as controls, received an intracardiac injection of 0·12 mgm. histamine per 100 gm. of body-weight. Group 2 first received an intraperitoneal injection of 15 gm. vitamin B_{12} ('Cytamen', Glaxo, standardized both colorimetrically and microbiologically for 'total vitamin B_{12} activity') per 100 gm. body-weight; after an interval of fifteen minutes, intracardiac injections of histamine were given as in group 1. All the animals in both groups died within a few minutes after severe bronchospasms. There was no significant difference in survival-times between the two groups. This did not confirm Traina's findings.

Table 1

Dose of histamine base (μgm./100 gm.)	Mortality
32	0/1
48	0/2
55	0/1
60	5/8
64	4/4

A possible explanation being that our guinea pigs were more susceptible to histamine, the approximate intracardiac toxicity of histamine in guinea pigs was assessed by injection of different doses, with the results shown in Table 1.

The experiments were now repeated, using two groups of eight guinea pigs treated as follows. Group 1: each animal received an intracardiac injection of 60 μgm. histamine base per 100 gm. of body-weight. Group 2: each animal was treated in the same way as those in group 1, but received 15–20 min. earlier a subcutaneous injection of 15 μgm. vitamin B_{12} per 100 gm. of body-weight. Five of each eight animals

Table 2

Cat	Time (min.)	Injection	Fall in arterial blood pressure
1	Initial	0·5 μgm. histamine per kgm.	37
	0	50 μgm. vitamin B_{12} " "	0·0
	13	0·5 μgm. histamine " "	35
	24	50 μgm. vitamin B_{12} " "	0·0
	36	0·5 μgm. histamine " "	36
	47	50 μgm. vitamin B_{12} " "	0·0
	53	0·5 μgm. histamine " "	32·5
2	Initial	0·5 μgm. histamine per kgm.	25
	0	50 μgm. vitamin B_{12} " "	0·0
	17	0·5 μgm. histamine " "	24
	32	0·5 μgm. histamine " "	25·7
	60	50 μgm. vitamin B_{12} " "	0·0
	90	0·5 μgm. histamine " "	27
3	Initial	0·5 μgm. histamine per kgm.	18·7
	0	500 μgm. vitamin B_{12} " "	12·0
	7	0·5 μgm. histamine " "	17·3
	27	0·5 μgm. histamine " "	18·3
	45	0·5 μgm. histamine " "	19·3

died, and no differences were noted in the survival-times or symptoms of the animals in the two groups.

With these doses of histamine, also, approximately the LD 50 under our conditions, we could thus not repeat Traina's results.

Blood-Pressure. (Cat, anæsthetized with intravenous chloralose, 80 mgm./kgm.). Three intravenous doses of histamine were given at 2-min. intervals. This procedure was repeated at intervals after the intravenous administration of vitamin B_{12}. The fall of arterial blood pressure following each histamine injection was recorded, and the mean fall (in mm. mercury) was estimated for each group of three injections. The results are presented in Table 2.

From these observations it may be concluded that injection of 50–500 μgm. B_{12} ('Cytamen', Glaxo) per kgm. has no effect on the depressor effect of histamine in the cat under chloralose anæsthesia.

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Occurrence of Eburicoic Acid

In the course of extensive studies on the metabolic products formed by the higher fungi, mainly of the class Basidiomycetes, grown on synthetic media, we examined a sample of decayed *Eucalyptus regnans* wood discovered at the Australian Newsprint Mills, Boyer, Tasmania, in 1944. From this mass of rotted wood encompassed with mycelial hyphæ, the acetyl derivative of a monobasic acid has been isolated. On hydrolysis this acetate (m.p. 256–257°; $[\alpha]_D^{20}$ + 35·8° (*c*, 3·1 in pyridine); found: C, 75·9; H, 10·1 per cent; molec. wt. (Rast), 455; $C_{29}H_{44}O_4$ requires C, 76·0; H, 10·1 per cent; molec. wt. 458) gave rise to the parent acid (m.p. 293°, $[\alpha]_D^{17}$ + 35·6° (*c*, 1·4 in pyridine); found: C, 77·9; H, 10·5; $C_{27}H_{44}O_3$ requires C, 77·9; H, 10·6 per cent), which appears to be a C_{27}- and not the more usual C_{30}- type of the triterpene group, examples of which are known to occur in naturally grown *Polyporos betulinus* Fr.[1].

From the decayed wood the organism responsible for this 'white rot' was isolated and identified as *Polyporus anthracophilus* Cooke and, when grown on a standard synthetical medium, containing glucose and glycine, was found to produce the parent acid (isolated from the mycelium) and not the acetate. From the literature it appeared that the acid from *P. anthracophilus* Cooke was in all probability identical with eburicoic acid, isolated along with agaracinic acid from the naturally grown fungus *Fomes officinalis* Fr., by Kariyone and Kurono[2], who give the melting point as 283° for their compound, which they named eburicoic acid and considered to have formula $C_{30}H_{48}O_3$; according to these authors, the acetyl derivative had melting point 240°, $[\alpha]_D^{17}$ + 80°, the methyl ester, melting point 141°, $[\alpha]_D^{23}$ + 37°, and the acetate of the methyl ester, melting point 150°, $[\alpha]_D^{23}$ + 56·9°. When grown on the synthetical medium, this mould has been found to produce the acid (m.p. 293°); but in this instance the crude compound is contaminated with a product of similar composition, having an ultra-violet absorption spectrum, maximum at 243 mμ, $E^{1\ \text{per cent}}_{1\ \text{cm.}}$ 37·8. From this mixture the acid (m.p. 293°) has been separated by chromatography on a column of aluminium oxide neutralized by acetic acid – methanol mixture. Although Kariyone and Kurono employed a hydrolysis process in the isolation of their eburicoic acid, it is not clear whether the naturally grown mould gives the free acid or the acetate. In spite of this difference in the melting points of Kariyone and Kurono's eburicoic acid and the acid produced by the moulds grown under artificial conditions and of some of their respective derivatives, we believe them to be identical.

In addition to the foregoing moulds, eburicoic acid has also been isolated from the mycelium of *Polyporus eucalyptorum* Fr., *P. sulfureus* (Bull) Fr., and *Lentinus dactyloides* Cleland. The following derivatives have been prepared in the course of the identification of eburicoic acid from various sources: methyl eburicoate (m.p. 140–141°; found: C, 78·1; H, 10·8; $C_{31}H_{48}O_3$ requires C, 78·2; H, 10·7 per cent), methyl O-acetyleburicoate (m.p. 153–154°; found: C, 76·6; H, 10·4; OMe, 5·3; $C_{33}H_{50}O_5$(OMe) requires C, 76·3; H, 10·2; OMe, 6·6 per cent) and *p*-nitrobenzyl eburicoate (m.p. 150·5°; found: C, 74·2; H, 9·1; N, 2·4; $C_{34}H_{49}O_5N$ requires C, 74·1; H, 9·0; N, 2·5 per cent). Experiments on the constitution of eburicoic acid are in progress.

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The de Haas–van Alphen Effect

Experiments by one of us[1] on the de Haas–van Alphen effect in gallium, tin and graphite (periodic field-dependence of magnetic susceptibility of metal single crystals) have now been extended to higher fields (up to 15,800 gauss), to lower temperatures (down to 1·1° K.), and to other metals; at the same time the theory of the effect has been reconsidered. The present note gives a brief account of the new results.

The effect has been shown to occur along the hexagonal axis of cadmium and perpendicular to the tetragonal axis of indium; for both metals the period of oscillation is very small (at 15,300 gauss about 43 gauss for cadmium and 48 gauss for indium). The amplitude is scarcely measurable except at the highest fields and lowest temperatures, so it is not surprising that the effect was not observed in the earlier experiments. Similar results have been found quite recently by Verkin, Lazarev and Rudenko[2], who have also observed the effect in magnesium and beryllium. More thorough experiments on a pure gallium crystal have shown that the effect is more marked and its character more complicated than the previous observations on a less pure crystal had suggested; the characteristics of the effect are different for each of the three principal axes. One interesting feature (which occurs also for tin and graphite) is the existence of beats in the oscillations, that is, periodic modulation of the envelope of the oscillations. The beat period varies in a complicated manner with field direction, and the depth of modula-

tion increases rapidly as the temperature is lowered. For certain directions in gallium at the lowest temperatures there is evidence also for a 'fine structure' of the oscillations, that is, superposition of a frequency several times higher than the fundamental. Presumably such features are at least partly associated with the co-existence of several groups of electrons with different effective masses.

The main theoretical advance has been the consideration of the influence of collision-broadening of the energy-levels in a magnetic field. This has been shown to diminish the amplitude of the leading term in Landau's theoretical formula[2] for the periodic field, dependence by a factor $\exp(-h/\tau\beta H)$, where τ is the appropriate collision time, β is $eh/2\pi mc$ (m being an effective electronic mass) and the other symbols have their usual meanings; thus the amplitude becomes proportional to $\exp[-(2\pi^2kT+h/\tau)/\beta H]$. In other words, the influence of collision-broadening is as if the temperature were increased by x, where $x = h/2\pi^2k\tau$, and x should be independent of temperature since at the temperatures concerned the electrical resistance, and hence τ, is independent of temperature. This modification of Landau's formula provides a possible explanation of a number of experimental features which did not previously fit the theory:

(1) In all the metals studied, the amplitude of the de Haas–van Alphen effect decays more rapidly with field at a given temperature than is to be expected, on the basis of Landau's formula, from the temperature-dependence at a given field; with suitable choice of x (usually of order a few degrees), the addition of the new exponential factor brings all the data into reasonable accord. It should be noted that if this is done, the effective electronic masses and degeneracy temperatures previously estimated from Landau's formula require some revision (though the orders of magnitude are unchanged).

(2) As the direction of the magnetic field departs from a principal axis, the amplitude of the de Haas–van Alphen effect decays more rapidly than is to be expected from the variation of the relevant effective mass. This can be accounted for by supposing that x increases with ψ, the angle between the field and the principal axis. In graphite, where conductivity is practically confined to the hexagonal plane, the circumstances are particularly simple, and the plausible result is found that x varies roughly as $\sec^2\psi$, that is, τ varies as $\cos^2\psi$; for the other metals the angular variation of x has not yet been fully studied.

(3) The decrease of amplitude of the de Haas–van Alphen effect with increasing impurity content[4] finds an immediate explanation, since x should be proportional to residual resistance, which increases with impurity content. In order to test this interpretation, some new experiments have been made on the influence of adding small amounts of mercury to tin. Preliminary results show that while the relevant effective masses and degeneracy temperatures are little affected, the value of x increases from about 2° K. for pure tin to 7° K. for addition of 0·8 per cent mercury. Although this confirms the idea that x increases with impurity, it is clear that the experimental parameter x is not proportional to the residual resistance, which is known to increase by a factor of order 150 for this addition of impurity[5]. This suggests that the experimental parameter x introduced to reconcile the field and temperature variations is not solely associated with collision-broadening, but may in part be due to other effects, and indeed in our purest tin is predominantly due to such other effects. If, however, we suppose that the increase of x with impurity-content is nevertheless to be identified solely with the increase of $h/2\pi^2k\tau$, a value of τ of order 10^{-10} sec. is obtained for our purest tin, of the same order of magnitude as the collision-time estimated from the anomalous skin effect[6] and the size-dependence of resistivity[7]. In the graphite specimen, the residual resistance of which in the hexagonal plane[8] is of order 10^3 times that of the pure tin specimen, it may, however, be unnecessary to invoke any mechanism other than collision-broadening. A possible cause for the residual value of x in tin, not associated with collision-broadening, is the removal by the periodic lattice field of the degeneracy of the electronic states quantized in a magnetic field. This removal leads effectively to a broadening of the relevant energy-levels, even in a completely pure metal.

Another puzzling discrepancy between the results for bismuth and zinc and Landau's formula has been the wrong phase of the oscillations[3,9] (available magnetic fields are too small to allow estimation of the phase for the other metals). Landau's theory assumes constancy with field of the number of electrons effective for the de Haas–van Alphen effect; but detailed considerations suggest that usually it is rather the thermodynamic potential per electron which should be constant, since only a very small fraction of the conduction electrons contributes to the effect. This leads to a phase change of $\frac{1}{4}\pi$ in the theoretical formula, which then agrees better with experiment, but it is possible that other effects not yet fully considered (for example, influence of the lattice field) may further change the phase, and modify the situation. The assumption of a constant thermodynamic potential also modifies the field variation of the envelope of the de Haas–van Alphen effect, changing a factor $H^{-3/2}$ which appears in Landau's formula to $H^{-5/2}$. Because of the dominant exponential factor, however, the experimental data cannot as yet decide between these two powers of H.

A full account of this work will be published later.

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The Uncertainty Relation

A most elegant demonstration of the uncertainty relation for two real observables A and B has been given by Born[1]. Let us denote mean values with a bar, and assume the linearity condition

$$\overline{aM + bN} = a\overline{M} + b\overline{N},$$

with a, b real constants, is satisfied for every two real operators M and N. Assume also

$$\overline{DD^*} \geqslant 0, \qquad (1)$$

where $D = M + iN$, $D^* = M - iN$.

Then putting $M = A\,;\ N = \lambda B$ (2)

and searching for a minimum of the left member of (1), Born arrives at the final conclusion that

$$(\Delta A)^2\,(\Delta B)^2 \geqslant \left|\frac{\overline{AB - BA}}{2}\right|^2, \qquad (3)$$

where $(\Delta A)^2 = \overline{(A - \bar{A})^2}$, $(\Delta B)^2 = \overline{(B - \bar{B})^2}$.

Formula (3) may be easily generalized if we do not choose the particular form (2) for M and N, and leave them as arbitrary real functions of A and B. For example, putting $M = A + \alpha B$, $N = \lambda B$, and determining α and λ so as to make the left member of (1) a minimum, we can easily obtain[2]

$$(\Delta A)^2\,(\Delta B)^2 - \left(\frac{\overline{AB + BA}}{2} - \bar{A}\bar{B}\right)^2 - \left|\frac{\overline{AB - BA}}{2}\right|^2 \geqslant 0, \qquad (4)$$

a formula which is due to Schrödinger[3].

Real functions of A and B may be obtained as a sum of terms formed with some real linear expressions in the products ρ_{rs} of order r in A and of order s in B. Denoting a general one of them by ${}_k\rho_{rs}$ we have, for example, for $r = s = 1$

$${}_1\rho_{11} = AB + BA \qquad {}_2\rho_{11} = i(AB - BA)\,;$$

for $r = 1$, $s = 2$

$${}_1\rho_{12} = AB^2 + B^2A \qquad {}_1\rho_{12} = BAB$$
$${}_2\rho_{12} = i(AB^2 - B^2A), \text{ etc.}$$

Taking for M and N two such functions and substituting in (1), we can clearly obtain other expressions of the type (3) or (4).

However, for practical evaluation of expressions containing the product $(\Delta A)^2\,(\Delta B)^2$, it is perhaps better to start from (4) instead of (1), with a process of successive generalizations.

Let us substitute $A + a\,.\ {}_k\rho_{rs}$ for A in (4), where ${}_k\rho_{rs}$ is one of the above-mentioned products and a a real constant. We obtain

$$(\Delta A)^2\,(\Delta B)^2 - \left(\frac{\overline{AB + BA}}{2} - \bar{A}\bar{B}\right)^2 - \left|\frac{\overline{AB - BA}}{2}\right|^2 + f(a) \geqslant 0. \qquad (5)$$

$f(a)$ has certainly a minimum: let it be $f(a_m)$ and let ${}_k\rho_{rs}$ be such that, for $f(a) = f(a_m)$, the left member of (5) does not vanish identically. $f(a_m)$ is certainly not > 0, because $f(0) = 0$ and then $f(a_m)$ would not be a minimum, contrary to the hypothesis. Suppose $f(a_m)$ is negative. Then (5) will actually be a more restricted condition for $(\Delta A)^2\,(\Delta B)^2$ than (4) is.

Now in the formula so obtained, let us make another substitution, say, $B + a\,.\ {}_k\rho_{rs}$ for B, or $A + a\,.\ {}_l\rho_{rs}$ for A, and repeat the process again. A yet more general formula may be obtained. The process can be carried on indefinitely, the substitutions being infinite in number.

The formulæ so obtained are rather complicated and involve higher products of A and B; thus one of them taken at random is:

$$(\Delta A)^2\,(\Delta B)^2 \geqslant \left(\frac{\overline{AB + BA}}{2} - \bar{A}\bar{B}\right)^2 + \left|\frac{\overline{AB - BA}}{2}\right|^2 + \frac{[(\overline{AB^2 + B^2A} - 2\bar{A}\overline{B^2})\,(\Delta B)^2 - (\overline{AB + BA} - 2\bar{A}\bar{B})\,(\overline{B^3} - \bar{B}\overline{B^2})]^2}{4\,[(\overline{B^4} - \overline{B^2}^2)\,(\Delta B)^2 - (\overline{B^3} - \bar{B}\overline{B^2})^2]}$$

In a recent paper, Reed and Dresden[4] have given a generalization of (4) in the case of products of more than two observables. It is clear that with our method the relations obtained by these authors can also be immediately generalized.

I wish to express my thanks to Prof. G. Wataghin for his assistance in this work.

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Reactions between Nucleons and Mesons, and the Search for Negative Protons

Several authors[1] have suggested that negative protons (p^-) may be emitted from β^--radioactive nuclei which emit a delayed neutron ($n_-{}^0$). (In our notations for the particles, the upper index refers to the charge, the lower one to the magnetic moment.) Some unsuccessful attempts[2] at detection have been made. This suggestion has originated from the fact that the rest energies of the neutron and an electron ε^- are together greater than that of p^- by 1·826 MeV. It will be shown in this communication that the above suggestion is unfounded.

The argument starts from the observation that the reactions

$$p^+ + n_-{}^0 = \pi^+ \qquad (1)$$
$$n_-{}^0 + n_-{}^0 = \pi_\pm{}^0 \qquad (2)$$

are impossible, since their occurrence would not be compatible with the existence of atomic nuclei. This fact rules out just those 'classes' of reactions which are necessary for the spontaneous emission of negative protons from nuclei.

We have already used[3] the concept of 'classes' of reactions for discussing whether neutrinos should be described as Majorana or Dirac particles. When there is one reaction between s particles, this automatically implies the existence of other reactions, and the whole set of reactions is called a 'class'. The reaction may be virtual or real, though the latter may be possible only if the necessary energy is supplied (for example, pair creation: $\pi^+ \to p^+ + n_+{}^0$).

We defined a reaction between s particles by the $2s$ numbers M_r, L_r (index r running from 1 to s). M_r, L_r are defined as follows: M_r is $+1$ or -1, according as the rth particle is emitted or absorbed. L_r is either $+1$ or -1, and it indicates the sign of the electric charge of the rth particle or, in the case of a neutral particle with a magnetic moment, the sign of the magnetic moment. If the neutral particle has only one state of 'charge conjugation', its field can be described by a real wave function (for example, photon, Majorana particle[4]); L is then arbitrary, and such a particle will be called a 'strictly neutral' particle.

We define

$$\mathrm{K}_r = \mathrm{M}_r\mathrm{L}_r \text{ and } \mathrm{K} = (\mathrm{K}_1, \mathrm{K}_2, \ldots \mathrm{K}_s). \qquad (3)$$

The conservation of the electric charge requires

$$\Sigma^c\,\mathrm{M}_r\mathrm{L}_r = \Sigma^c\,\mathrm{K}_r = 0, \qquad (4)$$

where Σ^c means the sum over the charged particles only.

The existence of a reaction, real or virtual, requires at least one constant of interaction, and this necessarily entails all other reactions with the same or opposite K. The set, or 'class', of all these reactions is therefore defined by $\pm$ K.

With the condition (4) we find that between: $p^{\pm}$, $p^{\pm}$, $\pi_{\pm}{}^{0}$ there can be only one class a_1; $p^{\pm}$, $n_{\pm}{}^{0}$, $\pi^{\pm}$ there can be only two classes, b_1, b_2; $n_{\pm}{}^{0}$, $n_{\pm}{}^{0}$, $\pi_{\pm}{}^{0}$ there can be only three classes c_1, c_2, c_3 of reactions. The impossibility of (1) and (2) excludes the existence of three classes. The other classes, a_1, b_1, c_1, have been used in several meson theories, and some of their reactions have been observed. (For describing all the different classes $\pm$ K it is necessary to use a Hamiltonian which contains the wave function ψ of the nucleons in expressions such as $\psi \mathrm{O} p \psi$, $\psi^{*} \mathrm{O} p \psi^{*}$ and $\psi^{*} \mathrm{O} p \psi$. It is possible to express the three classes, a_1, b_1, c_1, using only the last expression $\psi^{*} \mathrm{O} p \psi$, which can be interpreted as corresponding to transitions from negative to positive energies and vice versa, as opposed to the creation or annihilation of particles which requires the second quantization formalism.) These classes involve the creation or the annihilation of a pair of one nucleon (p^{+} or $n_{-}{}^{0}$) and one antinucleon (p^{-} or $n_{+}{}^{0}$), and therefore they rule out the stable existence of antinucleons in nuclei. Furthermore, with these three classes of reactions we cannot obtain from a nucleus with A nucleons an assembly of n antinucleons and $\leqslant A-n$ nucleons, even with an arbitrary number of intermediate virtual reactions. Hence it is impossible to observe the spontaneous emission of p^{-} (or $n_{+}{}^{0}$) from an atomic nucleus. The above argument is also valid for every kind of interaction between nuclear particles involving one or several intermediate particles the sum of the rest-masses of which is smaller than $m_p + m_n$. This includes the case of β-radioactivity.

These considerations on the classes of reactions between mesons and nucleons can be applied to the study of the mesic charge. As is well known, this charge is either of the Majorana type (f'_1, g'_1, f_1, f_2) in the Møller and Rosenfeld[5] notation, or of the Dirac type ($\pm f'_1$, $\pm g_1$, $\pm g_2$, $\pm g'_2$); in the latter case there is charge conservation. It is easily seen from the above considerations that, in the charged meson theories, p^{+} and $n_{-}{}^{0}$ always have the same mesic charge.

It is found that in all possible reactions of classes a_1 and c_1 the sign of $\mathrm{I}_{\pi}{}^{0}$ is immaterial. Let φ be the wave function of $\pi_{\pm}{}^{0}$; it appears in the interaction terms only through the combination $(\varphi + \varphi^{*})$. This is formally equivalent to the description of π^{0} as a 'strictly neutral' particle $\pi_{0}{}^{0}$. The two possibilities $\pi_{\pm}{}^{0}$ and $\pi_{0}{}^{0}$ are completely equivalent for all purely nuclear phenomena. This seems strong evidence for assuming that the (vector or pseudovector) neutral meson has no magnetic moment.

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Masses of Fundamental Particles

In considering the self-energy problem on the basis of the multiple-time formalism of quantum electrodynamics, Wentzel[1] has obtained the relation

$$m_n(s) = m_n + \frac{e^2 h}{8\pi^2 c^3 m_n s^2}, \qquad (1)$$

where $m_n(s)$ is the rest-mass of a field-free particle, m_n the corresponding mass in an electromagnetic field and s the particle extension. If we now assume that $m_n(s)$ and m_n refer to the masses of two fundamental particles M_1 and M_2 (expressed in terms of the electron mass m) it follows directly from equation (1) that

$$M_2 (M_1 - M_2) = \frac{e^2 h}{8\pi^2 c^3 m^2 s^2}. \qquad (2)$$

Putting $M_2(M_1-M_2) = (137/2)^2$ ($137 = hc/2\pi e^2$) and substituting for M_2 the proton mass 1836·56, it is found that M_1 is 1839·08; this is in excellent agreement with the experimental value of 1839·05 for the neutron mass. The mass values of the π- and μ-mesons do not fit unless we put $M_2(M_1-M_2) = 3(137/2)^2$, in which case, substituting for M_2 the μ-meson mass 208 (electron masses), we find that M_1 is 276. This value is again in excellent agreement with the experimental value for the π-meson mass. The final relation is then

$$M_2(M_1 - M_2) = K\left(\frac{137}{2}\right)^2, \qquad (3)$$

where $K = 1$ (neutron and proton); $K = 3$ (π- and μ-meson). It is reasonable to assume that the heavy τ-meson (mass approximately 810 electrons[2]) will be described by equation (3) with $K = 2$, and the neutrino by $K = 4$. In the case of $K = 4$, equation (3) reduces to

$$M_1 M_2 = 137^2 \text{ (since } M_1 \gg M_2), \qquad (4)$$

where M_2 is the neutrino rest-mass in electron units. Since the neutrino is intimately connected with the stability of the heavier atomic nuclei, we associate M_1 with a theoretical upper limit to the Periodic Table. Such an upper limit is given by the Sommerfeld relativistic theory of the motion of an electron around a nucleus in which the maximum possible atomic number is $Z = 137$. Using Bethe's[3] expression

$$\frac{A-2Z}{Z} = 0{\cdot}0146 A^{2/3} \qquad (5)$$

for the relation between the mass number A and the atomic number Z, and putting $Z = 137$, it is found that $A \approx 380$ ($\approx$ 700,000 electron masses). Substituting this value for M_1 in equation (1), the neutrino mass is found to be 0·0268 electron masses. The results may be grouped together in the following way:

K	M_1	M_2	
1	1839·08	1836·56	Neutron and proton
2	821	810	τ-mesons
3	276	208	π- and μ-mesons
4	700,000	0·0268	heaviest atom and neutrino

Having separated the masses of the fundamental particles into two groups, the significant result now appears that the M_2 mass spectrum may be accurately obtained from the simple relation

$$M_n{}^{1/3} - M_p{}^{1/3} = nS, \qquad (6)$$

where M_ν is the calculated neutrino mass (= 0·0268), $S = 14{\cdot}230$ and $n = 0, 1, 2, 3$. The accompanying table gives the values of M_2 as calculated from equation (6) together with the values of M_1 as obtained from equation (3).

n	M_2		K	M_1	
0	0·0268	(neutrino)	4	700,000	(heaviest atom)
1	207	(μ-meson)	3	276	(π-meson)
2	819	(τ-meson)	2	830	(τ-meson)
3	1836·56	(proton)	1	1839·08	(neutron)

It is significant that the dimensionless constant S in equation (6) may be accurately represented by $\sqrt{64\pi\beta}$ (where β is the Bond factor 137/136). This β factor occurs in Eddington's[4] theory as the ratio of identical components of the fie'd energy-tensor $W_{\mu\nu}$ and the total energy-tensor $T_{\mu\nu}$, and leads to mass relations of the type: field mass = $\beta \times$ total mass. It is not inconsistent with these ideas, therefore, that we find $\beta^{1/2}$ associated with the square roots of masses. Expressing the masses in equation (6) in absolute units, we have finally:

$$M_n^{1/2} - M_\nu^{1/2} = n\sqrt{64\pi\beta}\, m^{1/2}, \qquad (7)$$

where m is the electron mass. It is suggested that this relation expresses a new physical concept, and from the usual equivalence of mass and energy and the fact that energy is proportional to the square of a field amplitude, it would seem reasonable that equation (7) represents a simple linear relation between the amplitudes of the fields associated with the individual masses. It is hoped that further work will reveal the origin of this relation. An independent calculation of the neutrino rest-mass has been carried out by Konopinski[5] based on the half-life and β-decay of tritium. Taking the half-life as 25 years, the mass of the neutrino is found to be 0·0285 electron masses; this is in excellent agreement with the value obtained here.

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Possibility of Measuring a Quadrupole Transition Probability from an Auroral Afterglow

The green auroral line of oxygen at 5,577 A. ($^1D_2 - {}^1S_0$) has been found by Vegard and Kvifte[1], and Jenkins, Bowtell and Strong[2] in the afterglow of a Tesla discharge through argon, or a mixture of argon and nitrogen, at nearly atmospheric pressure, when there is a minute trace of oxygen present. It is accompanied by a diffuse band similar to one described by L. and R. Herman[3]. We have made some measurements of the decay of this phosphorescence, which can be followed by a photo-multiplier connected through an amplifier to a cathode ray oscillograph with a low-frequency time base. Three sources have been used, namely, two 300-watt commercial Osram gas-filled lamps, and a cylindrical tube 21 cm. long and 6 cm. in diameter containing a similar gas mixture, with two rod electrodes 2 mm. in diameter, mounted near one end with their tips 3 cm. apart. The photomultiplier was exposed to the glow from a volume of gas about 3 cm. in linear dimensions.

When the exciting discharge was cut off, the light recorded varied irregularly for about 0·2 sec. When not too erratic, its intensity followed roughly a recombination law. After this time, the light decayed exponentially for a little more than 1 sec., beyond which we could not follow it. The exponential decay was substantially the same when the light was viewed directly and passed through a Wratten No. 62 green filter. The decay constant was about 3·2 sec.$^{-1}$ for the light near the electrodes in the cylindrical tube, about 2·4 sec.$^{-1}$ for the far end of this tube, and about 2·6 sec.$^{-1}$ for the Osram lamps. These numbers are close to the value of 2·2 sec.$^{-1}$ for the Einstein quadrupole A coefficient calculated by Pasternack[4] from the wave functions of the ^1D and ^1S states, and it is of interest to consider if this simple experiment (and a similar one which might be done with high-pressure sources[5] of the ultra-violet N I line at 3,467 A.) gives a direct measure of a transition probability for an optical transition forbidden in the electric dipole approximation.

Unfortunately, it does not seem possible to show definitely that this is the case, owing to the complexity of the discharge and the disturbance of the gas produced by it. Jenkins, Bowtell and Strong[2] have pointed out that 'active nitrogen' phenomena may be involved, while much of the light comes from the continuum. In addition, the discharge did not fill the tubes uniformly, but consisted of a succession of thin sparks, surrounded by green aureoles which were brightest near where the discharge entered the gas from the Tesla coil. These sparks produced convection. With the electrode tube the upward-moving warm gas from the neighbourhood of the ends of the rods was visible as small green rising clouds. There was also a visible billowing of the luminous gas after the discharge had stopped. It is difficult to draw definite conclusions concerning atomic processes from observations on phosphorescent gas in this state.

Even if the irregularity of the discharge could be neglected, which is possible to a limited extent on account of the large volume scanned by the photo-multiplier, loss of metastable atoms by diffusion to the walls could give an approximately exponential decay with a modulus not much different from that observed. This can be shown by supposing, for example, that the actual volume containing the phosphorescent gas was replaced by a plane parallel system with about the same lateral linear dimensions ($2r$). If the concentration was zero at the walls and rose to a maximum at the centre, taken as origin, as $\cos \pi x/2r$, solution of the diffusion equation with a constant diffusion coefficient (D) shows that the concentration would decrease with time as $\exp -\pi^2 Dt/4r^2$. Inspection of values of D for small molecules[6] indicates that, allowing for the fact that the gas had been warmed by the discharge, its value for atomic oxygen under these conditions could be as high as 1 cm.^{2}/sec. Since r was of the order of $\pi/2$ cm., diffusion would thus cause decay to occur, if there were no other loss of excited atoms, approximately as $\exp -t$. This shows that diffusion to the walls may have contributed substantially to the observed decay, and that the difference in the decay constants for the two ends of the electrode tube may have been due to the presence of the electrodes effectively reducing the linear dimensions of the tube

at the end where they were situated. The initial distribution of excited atoms was almost certainly more complex, so that higher-order solutions with larger decay constants also have to be taken into account.

It is possible that a repetition of this type of experiment in a large vessel at a pressure sufficiently low to ensure uniformity of the discharge, but not so low as to make loss by diffusion overwhelmingly great, might allow the various processes involved to be sorted out, and hence give an experimental value for the quadrupole transition probability.

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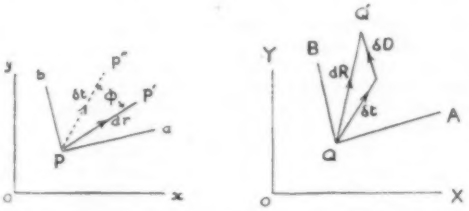
A Linear Theory of Finite Strain

Several papers have been published by Dr. K. H. Swainger in which he claims to have originated a linear theory of elasticity involving finite strain, and he has questioned, not only the approach of other workers in the same field, but also the classical infinitesimal theory, since these appear to be in conflict with his own[1,2]. The purpose of this communication is to show that this new theory is untenable, since a mathematical inconsistency enters at the very beginning.

Dr. Swainger bases his discussion of strain on the following ideas (for simplicity the two-dimensional case will be considered). Let the points Q, Q', and hence the element $d\mathbf{R}$, in the strained body correspond to P, P' and $d\mathbf{r}$, respectively, in the unstrained body.



At P there exists a unique pair of directions Pa, Pb which are orthogonal and which transform into a pair of orthogonal directions QA, QB in the strained body[3]. Suppose that the axes Pa, Pb are rotated about P until they are parallel to QA, QB, carrying $d\mathbf{r}$ with them into a new position $\delta\mathbf{t}$. Then the infinitesimal straining displacement of Q' relative to Q is defined by the relation

$$\delta\mathbf{D} = d\mathbf{R} - \delta\mathbf{t}. \qquad (1)$$

For a point S at a finite distance from Q the straining displacement of S relative to Q is then defined as

$$\mathbf{D} = \int_Q^S \delta\mathbf{D} = \int_Q^S d\mathbf{R} - \int_Q^S \delta\mathbf{t}, \qquad (2)$$

the rotation described above being applied to each element $d\mathbf{r}$ of the path in the unstrained body which corresponds to QS. In the subsequent theory this quantity $\mathbf{D}$ replaces the conventional displacement

$$\mathbf{U} = \int_Q^S d\mathbf{R} - \int_Q^S d\mathbf{r}. \qquad (3)$$

It is tacitly assumed throughout Dr. Swainger's theory that $\mathbf{D}$ has a meaning; that is, that the process employed in its derivation is independent of the particular path between Q and S in equation (2). This is, however, false. Let the 'local rotation' at P necessary to bring the direction of Pa into coincidence with that of QA be denoted by φ, an angle which is in general a function of position. It does not follow, of course, that any arbitrary function can be chosen to represent φ, since such a choice may not be consistent with the physics of the problem. However, the non-integrability of $\delta\mathbf{D}$ will be shown without any restrictions on φ whatsoever, beyond the assumption that it is a continuous one-valued function of position.

From equation (1), $\delta\mathbf{D}$ is a perfect differential only if $\delta\mathbf{t}$ is. Let $d\mathbf{r}$ have components dx, dy parallel to the axes of a fixed reference system Oxy. Then

$$\delta t_x = dx\cos\varphi - dy\sin\varphi,$$
$$\delta t_y = dx\sin\varphi + dy\cos\varphi,$$

must be perfect differentials; that is, one-valued quantities t_x and t_y must exist such that

$$\frac{\delta t_x}{\delta x} = \frac{\delta t_y}{\delta y} = \cos\varphi, \quad \frac{\delta t_x}{\delta y} = -\frac{\delta t_y}{\delta x} = -\sin\varphi.$$

But these are the Cauchy–Riemann relations and are sufficient to ensure that $\tau = t_x + it_y$ is an analytic function of $z = x + iy$, regular in the region under consideration.

Hence

$$\frac{d\tau}{dz} = \frac{\delta t_x}{\delta x} + i\frac{\delta t_y}{\delta x} = \exp i\varphi$$

is also a function of z, so that φ must be a function of z. But φ is a real quantity, and as such can only be a constant.

Hence the quantity $\mathbf{D}$ used in Dr. Swainger's theory has a meaning only for irrotational strain (apart from a possible rigid-body rotation which may also be superimposed). In these circumstances it is effectively equivalent to the conventional displacement defined in equation (3).

A. N. Gordon
Imperial College of Science and Technology,
London, S.W.7.

[1] Swainger, K. H., *Nature*, **164**, 23 (1949).
[2] Swainger, K. H., *Nature*, **165**, 159 (1950).
[3] Love, A. E. H., "Mathematical Theory of Elasticity".

Dr. Gordon describes a theory of 'straining' that is certainly not mine. Dr. Gordon merely discusses the rotation of an assembly of elemental *rigid* blocks (or the undeformed body) with initial vector diagonal $d\mathbf{r}$ and current diagonal $d\mathbf{t}$, and correctly finds that since the body is not deformable then it can only

rotate as a whole (or be translated). Dr. Gordon gives no indication of what is to be understood as 'strain' in order to allow examination of the compatibility conditions mathematically necessary to ensure integrability to give 'displacements'.

A short letter cannot include a proper discussion of my theory on straining and its developments in reply to Dr. Gordon, so just the results and their source will be indicated for reference. A deformable body is an aggregate of *points* (not blocks) suffering vector field spatial-displacement **U** from initial position **r** to current position **R** with respect to fixed reference *Oxyz*. The forces **F**, say, induce a 'true' stress vector field $\mathbf{S}_i$ in the current *deformed* body which constitutes a unique reference region. Imbed 'whole-body convected axes' *O'*123 at arbitrary origin *O'* in the *deformed* body[1,2]. With respect to *O'*123, the stresses $\mathbf{S}_i$ are invariant, but with respect to *Oxyz* they are variant if *O'*123 rotates relative to *Oxyz*.

The straining-displacement **D** of a point is from the 'instantaneously initial' position **t** relative to *O'*123. Its spatial-displacement **U** is from the initial position **r** relative to *Oxyz*. **D** is invariant relative to *O'*123, but **U** is variant if *O'*123 rotates relative to *Oxyz*. One–one correspondence between the vector fields of $\mathbf{S}_i$ and **D** is ensured by referring to the whole-body convected axes *O'*123. If *O'*123 coincides with *Oxyz*, then **D** equals **U** and the 'whole-body rotation' is zero. Dr. Gordon has not understood this aspect because, in general, such zero 'spatial-rotation' can be given arbitrarily to one point only. Substance about a typical point **R** in the deformed body has suffered 'straining-rotation' relative to *O'*123 in general.

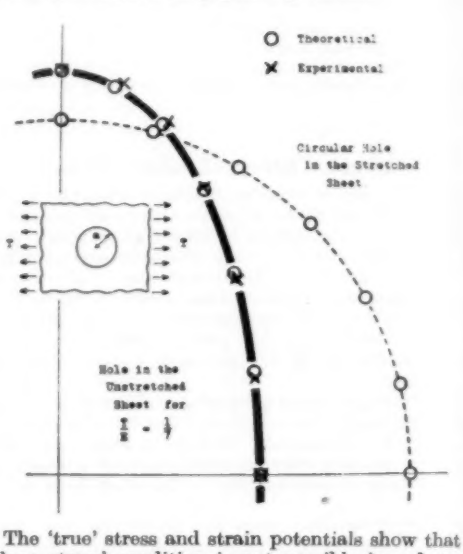
'Locally convected axes' *QABC* for which the unit vectors are **A**, . . . are described in the directions of principal normal 'true' strains e_A, . . . in the *deformed* body. Then an observer *relative* to *QABC* would record the differential relative straining-displacement that has occurred between the ends of $d\mathbf{R}$ as, say, $d\mathbf{D}^* = d\mathbf{R}.\Sigma e_A \mathbf{AA} = d\mathbf{R}.\Phi$. The spatial translation and rotation from *Pabc* to *QABC* does not affect the observation, so that in this 'local' sense *strain* is always 'pure'. Dr. Gordon seems confused on this aspect. The local strain for *all* such points **R** is now analysed with respect to the common 'whole-body convected axes' *O'*123 for relation to the stresses by the usual generalized Hooke's law, say, but using 'true' stress-strain parameters.

An observer at *O'* would see that at **R** the differential relative straining-displacement relative to him is $d\mathbf{D} = d\mathbf{R}.\text{grad}\,\mathbf{D}$. The difference between $d\mathbf{D}^*$ and $d\mathbf{D}$ is due to straining-rotation relative to *O'*123 and is accounted for by the straining that has occurred *between* *O'* and **R**. So far as point **R** is concerned, its straining-rotation is due to action at a distance from it. My thesis is essentially that, relative to the deformed body,

$$\text{grad}\,\mathbf{D} \approx \text{grad}\,\mathbf{D}^* = \Phi.$$

I am at fault in referring previously to 'equality' rather than 'equivalence' of **D** and $\mathbf{D}^*$ as here. This 'equivalence' is implied in the classical infinitesimal strains theory when shear strain is defined as $(U_{x;y} + U_{y;x})$ to eliminate the small spatial rotation ω_z of an element. Again, the spatial-rotation is not recognized explicitly but eliminated when Cauchy's (1827) stretch-ratio, $(dR/dr)^2$, is formed as usual to study finite strain. By taking the square root of the invariant quadratic strain metric suitably, my linear theory can be evolved[3].

Since Φ is a point function then $d\Phi = d\mathbf{R}.\text{grad}\,\Phi$. The strains compatibility conditions occur as identities to satisfy[4] grad Φ. For an isotropic substance these are essentially nine first-order equations and are more restrictive physically than Saint-Venant's six second-order conditions. The direct application of Helmholtz's theorem on 'irrotational' and 'solenoidal' components of a vector field[4] indicates that for infinitesimal deformation the 'straining-rotation' is a second-order small quantity[4], so that in this case 'spatial-rotation' is constant to first-order accuracy while $\mathbf{D}^*$ equals **D**. Beltrami's method of deriving Saint-Venant's compatibility conditions[4] then gives my nine first-order equations. The strains compatibility conditions emerge most clearly by defining a 'displacement-potential' $\mathfrak{D}$ and a 'stress-potential' $\mathfrak{H}$, where self-conjugate strain dyadic $\Phi = \text{grad grad}\,\mathfrak{D}$, while self-conjugate stress dyadic[4] $\Phi = \text{grad grad}\,\mathfrak{H}$[7]. 'True' stresses and strains exhibit the same symmetry and laws of transformation as one might expect on physical grounds.



The 'true' stress and strain potentials show that a 'plane stress' condition is not possible in a heterogeneous stress distribution. However, regarding 'plane stress' as approximating to reality, a solution has been found for a circular hole of radius a in a *deformed* highly elastic sheet under simple tensile true stress T at infinity[3]. The arbitrary restriction to 'plane stress' led to 'true' equations of precisely the same *form* as the classical infinitesimal strains set solved by Kirsch (1898). The whole-body rotation is zero in this case and scalar straining-displacement components D_r, D_θ in polar co-ordinates (r,θ) with 'true' Young's modulus E and Poisson's ratio q are, with $r/a \equiv f$ and $2E/(aT) \equiv G$,

$$GD_r = [(1+q)(f-f^{-3}) + 4f^{-1}]\cos 2\theta + (1-q)f + (1+q)f^{-1}$$

$$GD_\theta = -[(1+q)(f+f^{-3}) + 2(1-q)f^{-1})]\sin 2\theta,$$

with co-ordinates referring to the point in the *deformed* body. Experimental measurements on a *thin* rubber sheet check closely with these displacements.

The accompanying figure from my paper[3] shows values at the boundary of the hole. Cauchy strains of order 65 per cent occur at $\theta = 90°$, while at $\theta = 60°$ straining-rotation is of order 30°. These are certainly finite values. Other cases of 'plane stress' and 'plane strain' that have been solved are a severely deformed quadrantal cantilever[4] and a cylinder generated from a flat plate[5]. Solutions of the three-dimensional equations are required. Poisson's is the governing equation and indicates complete analogy with the electrical equations. Stress potential is analogous to electric potential, and stress is analogous to gradient of electric force[7].

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[1] Swainger, K. H., *Phil. Mag.*, **38**, 422 (1947).
[2] Proc. Seventh Intern. Congr. App. Mech., London, Sept. 1948.
[3] Communicated to *Quart. J. Mech. and App. Math.* (June 1950).
[4] Communicated to *Quart. J. Mech. and App. Math.* (July 1950).
[5] Love, A. E. H., "Mathematical Theory of Elasticity", 49 (Cambridge Univ. Press, 1934).
[6] Weatherburn, C. E., "Advanced Vector Analysis" (G. Bell and Sons, 1937).
[7] Swainger, K. H., communicated to *J. Franklin Inst.* (April 1950).
[8] *App. Sci. Research, Holland* (in the press).
[9] *J. App. Mech.*, **15**, 45 (1948).

Anomalous Results of Moth-Proofing Tests

THE findings reported by Lamb under this title[1] are unusual but may be explained along the following lines.

When either of the two moth-proofing agents was applied from acid solution at 60° C., the fabric behaved normally; it had acquired a good proof which gradually diminished in efficiency on repeated washings, because some of the moth-proofing agent was gradually washed out.

When the proofing agent was applied to the fabric along with a dyestuff from a neutral bath at 100° C., and the bath was acidified only just before the removal of the fabric from it, the quality of the proof was unsatisfactory. The reason is probably that the proofing agents were applied incorrectly; they are often supplied as sodium salts[2] which have little or no affinity for the wool, and they must be converted into the free sulphonic acids in order to gain substantivity. In the experiment which Lamb describes, this acidification was made only just before the fabric was removed from the bath; the proofing agents, now in the form of free sulphonic acids, would immediately attach themselves to the wool, but irregularly, because before they had time to penetrate the fabric thoroughly, the fabric was removed. Acid dyestuffs behave similarly; they may be completely applied to the wool in a few minutes, but are irregularly distributed, and dyeing is ordinarily continued for perhaps another half-hour for levelling to take place, for the dyestuff to distribute itself uniformly. Moth-proofing agents of the type described by Lamb are in effect colourless dyestuffs; they were applied irregularly and had no time to level up. The poor quality of the proof was due to the irregularity of application of the proofing agent.

When the fabric which had the unsatisfactory proof was washed several times with a commercial soap powder, the quality of the proof improved a little. The reason may well be that during washing some opportunity for redistribution over the fabric would be afforded to the proofing agent, still present on the wool as the free sulphonic acid (good commercial soap powders are neutral or nearly so). The more uniform distribution of the moth-proofing agent would improve the quality of the proof; there would be some loss of proofing agent during washing, but whereas this loss would have a small adverse effect on the quality of the proof, its effect would be more than counterbalanced by the improvement in the proof due to the more uniform distribution of the proofing agent.

R. W. MONCRIEFF

3 Church Square,
Harrogate.

[1] Lamb, K. P., *Nature*, **166**, 37 (1950).
[2] Moncrieff, R. W., "Mothproofing", 68 (London, 1950).

Ancient Bored Stones

WITH reference to Mr. A. J. H. Goodwin's recent letter under the head of "South African Stone Age Terminology"[1], may I point out that the type station of the Magosian is in Uganda, not in Kenya[2], and in doing so remedy an omission.

I found the Magosi site in 1925 and surveyed and dug it in November 1926, with the aid of funds supplied by the Percy Sladen Trustees. All the many artefacts recovered were sent to Mr. M. C. Burkitt for study and description—or so I thought; but I was away when they were dispatched, and long afterwards I discovered that one specimen, the largest and the only one of its kind, had been omitted from the parcel, and therefore from the description of the culture. It was a rather poor but indubitable example of a bored stone. Unless my memory fails me, it came from the 2–4 ft. level. It was at that time, so far as I know, the oldest on record.

In this connexion it is interesting to note that in December 1949 I was shown, in the National Museum, Bulawayo, a bored stone recently found in association with a Magosian culture in Southern Rhodesia, and was told of another.

Here, perhaps, is the place to recall that nearly twenty years ago I published a short account of a bored stone I had recovered, sixteen months previously, from well-bedded sands and areno-argillaceous beds at a depth of 16 ft. below a rubble deposit (itself covered by about 4 ft. of undisturbed red earth) rich in East African Acheulean implements[3]. This was apparently the *M*-horizon[4], and the bored stone was *in situ*. A considerable problem was thus raised.

Three years ago, I seized the chance to re-investigate the matter, and further excavation into the supposed *M*-horizon, near the shaft that had yielded the bored-stone, produced not only cleavers, hand axes and other Acheulean-type implements, but also two pieces of flat, artificially ground stone. Clearly the originally supposed *M*-horizon is spurious and re-made, and is bored-stone or post-bored-stone in age.

The significance of the deposits yielding this artefact, and of the pseudo-Acheulean rubble layer above them, will be discussed elsewhere.

E. J. WAYLAND

Geological Survey,
Lobatsi,
Bechuanaland Protectorate.
July 19.

[1] *Nature*, **165**, 1026 (1950).
[2] Wayland, E. J., and Burkitt, M. C., *J. Roy. Anthrop. Inst.*, **62**, 369 (1932).
[3] *Nature*, **128**, 103 (1931); and *Uganda J.*, **1**, No. 1, 69 (1934).
[4] Wayland, E. J., Bull. 2, Geol. Surv. Uganda, 69 (1935).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 16

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. Philipp Frank: "The Positivistic, the Metaphysical and the Sociological Interpretations of Science".

Tuesday, October 17

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. N. F. Kristy: "The Vocational Guidance Programme of the U.S. Veterans Administration".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. M. Abercrombie: "Unresting Cells".*

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. K. L. Blaxter: "Iodinated Proteins and Thyroxine in Animal Husbandry".*

UNIVERSITY OF LONDON (in the Wright-Fleming Institute Lecture Theatre, St. Mary's Hospital Medical School, Paddington, London, W.2), at 5 p.m.—Prof. U. S. von Euler: "Hormones of the Sympathetic Nervous System and the Adrenal Medulla".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. T. H. Davey: "Colonial Medical Policy in relation to Population Growth".*

ROYAL SOCIETY OF MEDICINE, PATHOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Prof. Wilson Smith: "The Evolutionary Approach to Problems of Infection" (Presidential Address).

Wednesday, October 18

ROYAL INSTITUTE OF CHEMISTRY (at the Cora Hotel, Upper Woburn Place, London, W.C.1), at 3.30 p.m.—Symposium on "The Chemist Outside the Laboratory".

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the Scientific Film Association, at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "The Use of Films in Meteorology".

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Prof. A. Haddow: "Recent Progress in the Study of Carcinogenesis" (Presidential Address).

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. R. J. Sarjant: "Ignipotence" (Melchett Lecture).*

Thursday, October 19

PHYSICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. D. W. Fry: "Work on the Linear Electron Accelerator"; Dr. G. P. S. Occhialini: "Physical Problems in Cosmic Ray Research".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. L. G. Muir: "Scientific Method in Mining"; Prof. David Williams: "Gossanized Breccia-Ores, Jarosites and Jaspers at Rio Tinto, Spain".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. L. G. Romell: "Experimental Forest Ecology".* (Further Lecture on October 20.)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. R. Hills: "Use of Wind Tunnel Model Data in Aerodynamic Design".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the Northern Ireland Section, in the Agricultural Chemistry Department, Queen's University, Elmwood Avenue, Belfast), at 7.30 p.m.—Dr. J. B. M. Coppock: "The Application of Science in the Baking Industry".

Friday, October 20

BIOCHEMICAL SOCIETY (at the National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7), at 11 a.m.—Scientific Papers.

BRITISH MYCOLOGICAL SOCIETY (joint meeting with the Association of Applied Biologists, in the Main Lecture Theatre, Huxley Buildings, Imperial College of Science and Technology, Exhibition Road, London, S.W.7), at 11 a.m.—Discussion on "The Plant and the Law".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

CHEMICAL SOCIETY, BIRMINGHAM SECTION (joint meeting with the University Chemical Society, in the Chemistry Department, The University, Edgbaston, Birmingham), at 4.30 p.m.—Dr. E. J. Bowen, F.R.S.: "Chemistry and the Scattering of Light".

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE SECTION (joint meeting with the St. Andrews University Chemical Society, in the Chemistry Department, United College, St. Andrews), at 5 p.m.—Prof. J. Read, F.R.S.: "Historical Science as an Instrument of Culture".

COUNCIL FOR THE PROMOTION OF FIELD STUDIES (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Mr. M. C. Burkitt: "Archæology, Education and Field Work".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. S. F. Dorey: Presidential Address.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne), at 6.15 p.m.—Annual General Meeting; Sir Philip Johnson: Presidential Address.

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. H. L. Penman: "The Role of Vegetation in Meteorology, Soil Mechanics and Hydrology".

CHEMICAL SOCIETY, ABERDEEN SECTION (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Dr. R. Hurst: "Recent Work on the Transuranic Elements".

Friday, October 20—Saturday, October 21

INSTITUTE OF BIOLOGY AND THE ATOMIC SCIENTISTS' ASSOCIATION WITH THE SUPPORT OF THE BRITISH ASSOCIATION (at the Royal Institution, 21 Albemarle Street, London, W.1).—Conference on "The Biological Hazards of Atomic Energy".

Friday, October 20

At 10 a.m.—"Biological and Medical Effects of Nuclear Radiations"; at 2.15 p.m.—"Tolerance Levels and Measures of Protection".

Saturday, October 21

At 10 a.m.—"Biological Implications"; at 2.15 p.m.—"Atomic Energy and the Future".

Saturday, October 21

BRITISH PSYCHOLOGICAL SOCIETY (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. J. C. Flugel: "The British Psychological Society".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST to carry out investigations on the problem of spray retention on foliage, at the Long Ashton Research Station, on behalf of the Colonial Insecticides Committee—The Secretary, The University, Bristol (October 21).

DEPUTY GENERATION DESIGN ENGINEER in the Chief Engineer's Department at London headquarters—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting Ref. AE/100 (October 21).

LECTURER IN MATHEMATICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (October 21).

RESEARCH ASSISTANT IN THE DEPARTMENT OF ECONOMICS AND COMMERCE, to undertake research upon the wool trade—The Registrar, The University, Leeds 2 (October 21).

SENIOR HOSPITAL PHYSICIST for the new radiotherapy department at the Churchill Hospital, Headington—The Administrator, Radcliffe Infirmary, Oxford (October 21).

TEACHER (temporary, full-time) OF CHEMISTRY—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (October 21).

ASSISTANT in the Medical Department, London headquarters, to be Junior Editorial Assistant on the staff of the *British Medical Bulletin*—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, endorsed 'Medical' (October 23).

SENIOR LECTURER IN CHEMISTRY—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (October 23).

SENIOR ASSISTANT ENGINEER on the staff of the Chief Engineer to the Devon River Board—The Chief Engineer, County Surveyor's Office, New North Road, Exeter (October 24).

SENIOR LECTURER IN BACTERIOLOGY, and an ASSISTANT LECTURER IN BIOCHEMISTRY, at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 31).

ANALYST to take charge of the Chemical Laboratory connected with Crop Testing—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

CIVIL ENGINEER by the Nigerian Government Electricity Undertakings—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.25440/3A.

CIVIL ENGINEERS and SURVEYORS for road and bridge construction and for location surveys, by the Public Works Department of Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Great Smith Street, London, S.W.1, quoting No. 27322/191.

ELECTRICAL ENGINEERS (electrical distribution) by the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.25016/3B.

HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT—The Clerk and Treasurer, Dundee Technical College, 40 Bell Street, Dundee.

LECTURER IN METALLURGY at the County Technical College, Wednesbury—The Director of Education, Department F.E., County Education Offices, Stafford.

MECHANICAL ENGINEER (Ref. M.N.25450/3B), and an ELECTRICAL ENGINEER (hydro-electric) (Ref. M.N.25728/3B), by the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

PHYSICISTS (4) interested in fundamental research on the properties of matter—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PROFESSOR OF ANATOMY, a PROFESSOR OF RADIOLOGY, and a PROFESSOR OF PHARMACOLOGY, by the Government of Iraq for the Royal Hospital and Medical College—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.S.A.922/5/3F.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government Departments, and for a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission (Scientific Branch), 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2887.